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Second Edition.

THE
THEORY AND PRACTICE
OF THE
DRILL HUSBANDRY;
FOUNDED UPON PHILOSOPHICAL PRINCIPLES, AND
CONFIRMED BY EXPERIENCE.

CONTAINING

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|--|---|--|
| I. A Dissertation on the <i>Natural Food</i> of Plants. | { | on any Kind of Land, in any given Quantity, and |
| II. A Dissertation on the Shape and Size of the
Roots of such Plants as are the Object of Field
Culture. | | at any proper Depth and Distance required. |
| III. A Dissertation on the superior Advantages of the
Drill to the Broadcast Husbandry. | | V. General Directions for preparing the Land, and
for using the different Machines, in the Sowing or
Planting all Kinds of Grain, Pulse, Seeds, &c. |
| IV. Full Directions for making two different Kinds
of Drill Machines, and a Drill Plough, for Sowing
or Planting all Kinds of Grain, Pulse, Seeds, &c. | | VI. Full Directions for making several Kinds of
<i>Horse and Hand Hoes</i> , with proper Instructions for
Horse and Hand Hoeing all Kinds of Grain, Pulse,
Seeds, &c. with different Kinds of Hoes. |

Illustrated with

EXACT DRAWINGS OF ALL THE RESPECTIVE PARTS, AND A
PERSPECTIVE VIEW OF EACH MACHINE COMPLETE, ON
NINE COPPER PLATES,

WHEREBY EVERY FARMER WILL BE ENABLED TO MAKE HIS OWN DRILL MACHINES:

BY WILLIAM AMOS,

Steward to John Cartwright, Esq. of Brothertoft near Boston, Lincolnshire.



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HUMBLE SERVANT

WILLIAM AMOS.

THE HISTORY OF THE

PROGRESS OF THE

ART OF PRINTING

IN GREAT BRITAIN

FROM THE FIRST

TO THE PRESENT

STATE OF THE ART

BY JOHN WELLS

P R E F A C E.

OF all the arts in the world, none are so ancient as that of Husbandry, which boasts an origin coeval with the human race; nor is there any so useful, so profitable, so healthful, so delightful, and so salutary to the mind as that of Agriculture.

It is also an occupation that none can rival in connecting private interest with that of the public, for every step that a

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man makes for his own good promotes that of his country.

It has been my province, through the greatest part of my life, to be employed in the art of Husbandry; and being strongly attached to rural pursuits, I engaged in the study of it with an ardour equal to the pleasure it afforded, and natural to the impetuosity of youth.

The following sheets are the result of attentive study and diligent observation, and I hope will contribute not a little to the advancement of Agriculture.

In

In the prosecution of this work, I have taken a general survey of the first principles or elements, viz. FIRE, WATER, AIR, and EARTH; and endeavoured to show how those elements become the *natural food of plants*; how vegetation, secretion, and absorption are performed by their presence and agency; how NATURE employs them in restoring that *food* to land impoverished by cropping, or rendered defunct by indiscreet management; and how NATURE is particularly assisted therein by the Drill-Husbandry.

I have likewise given a particular ac-

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count of the construction and use of two different kinds of Drill Machines, and of a Drill Plough (which for cheapness, simplicity, strength, and perfection, are superior to any now extant), for sowing or planting all kinds of grain, pulse, seeds, &c. and at a price accommodated to the circumstances of farmers of all ranks and degrees.

I have also pointed out the method of cultivating and preparing the land, so as to make it produce the largest crops possible, with the least expence.

I have at the same time given proper
directions

directions for making and using several kinds of *hoes*, for hoeing all kinds of grain, pulse, feeds, &c.

To the following authors I stand indebted : Sir Torbern Bergman, the Bishop of Landaff, the Rev. Dr. Priestley, Dr. Hunter of York, and Monf. Duhamel: I make this public acknowledgment, to avoid the charge of plagiarism.

I shall not here make any apology for offering this to the Public. By those who think there is no need of any, none will be expected ; and by those who think there is, perhaps the best will be deemed insufficient.

insufficient. At the same time I deliver this book to the world with all the anxiety and diffidence natural to an author in publishing his first essay.

The time I have employed, the pains I have taken, and the expence I have been at in order to render it worthy of the title it hath assumed, and of the public approbation, it is perhaps prudent to conceal, till it be known whether that approbation will ever be bestowed upon it.

ADVERTISEMENT.

SEVERAL years have elapsed since I announced this work to the Public ; but the number of experiments and improvements that I was then engaged in making, together with the duties of my office, rendered a proper attention to the press almost totally incompatible. However, the result of those experiments and improvements, which are introduced into this work, will, I hope, make sufficient atonement for the delay in publishing.

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THE
THEORY AND PRACTICE
OF THE
DRILL-HUSBANDRY.

DIRECTED by instinct, animals seek their own proper food ; but vegetables, not being possessed of the power of motion, must be satisfied with the nourishment which *nature* or *art* giveth them.

Human *art*, with much labour and expense, gives nourishment to vegetables, by mixing dung and other substances with the soil on

B which

2 THEORY AND PRACTICE

which they grow ; but the way by which *nature* gives them their food is simple and easy : her œconomy in this respect is transcendently beautiful and astonishing ; and no mode of culture is better adapted to assist nature in communicating that food to vegetables, and to the earth on which they grow, than the Drill-husbandry.

CHAP.

C H A P. I.

On the Natural Food of Plants.

IN no branch of Natural Philosophy has imagination and conjecture been more freely indulged, than in what concerns the *food of plants*. Nor has any subject engaged more the attention of so many learned and ingenious gentlemen, who, with the assistance of the art of chemistry, have made great progress in that important investigation: and from the result of their various experiments, which have been accurately made, it indubitably appears, that a due combination of the four elements, viz. FIRE, WATER, AIR, and EARTH, constitute, not only the *food and nourishment* of vegetables, but also forms the constituent parts of all bodies, and are all the materials employed in the formation of the stupendous works of creation. For the better understanding of which, I shall give a brief analysis of those elements; and,

I. *Of* FIRE.

By *fire* is understood a complex idea of something *red, shining, that excites the sensation of heat, and rarifies and expands all known bodies.* But so little do we know of *fire*, that any attempt at a theory of it must appear presumptuous and premature. We find, however, that *fire or heat, phlogiston, the electrical fluid, and light,* have so many qualities and properties alike, that many think them only different modifications of the same principle.

FIRE is the action by which a proper body is deprived of *phlogiston*, by means of pure air, with such vehemence as to generate not only heat, but flame. And this flame is *phlogiston* in an active, volatile, or fluid state.

According to this acceptation of the word *fire*, it is the most *essential fluid* in nature, and the cause of fluidity in other bodies, by separating their parts; hence even air itself would become solid if
it

it could be entirely deprived of the fire it contains, as bodies of the most difficult fusion become fluid when penetrated by a sufficient quantity of its particles.

Hence we have reason to believe, that *air*, *water*, and *earth*, are only variations of the same element, introduced by heat: for, without a certain degree of heat, water, spirits of wine, oil, quicksilver, and even air itself, would be converted into solid bodies; and, with a certain degree of heat, all fluid bodies would be changed into elastic vapours, and all solid bodies would either be wholly dissipated, or in part dissipated and in part converted into fluid glass: for the most dense and compact of all bodies, which resists the most violent fires excited in the greatest furnaces, without losing any thing of their weight, can be formed into elastic vapour by the fiercer action of the solar rays, when united in the focus of a large burning-glass: exemplified by gold, diamonds, rubies, &c. which the famous *burning-glass* at Paris can turn into elastic vapour. It is the most powerful agent in the decomposition of bodies, and the source of
all

all sublunary forms and solutions, by increasing the repulsive quality in all bodies; and the force of that law is so unlimited, as to counteract the power of gravity, by causing all bodies to ascend, even the most solid.

All nature is kept in motion by fire; even blocks and stones swell by the heat of the day, and contract by the cold of the night. Air and water are kept in a state of fluidity by it. The former is so swelled by it, that, to keep up the equilibrium, it is perpetually agitated by winds and storms; and to the latter it gives so repulsive a quality that it flies off in steam: hence it is that *fire*, or *heat*, becomes a stimulating and vivifying principle in vegetation.

PHLOGISTON is not *fire*, but the principle or *pabulum* of inflammability; *i.e.* when it is combined with various substances in due proportion, it renders them inflammable: hence we have reason to believe, that it is this gas in a concrete state, in coals, candles, wood, metals, &c. that makes them inflammable. For the inflammation of coals,

candles, wood, paper, pitch, tar, oil, and other combustible bodies, arises from this gas being separated from them by heat, and inflamed by the contact of fire, which continues to burn as long as the body continues to afford a proper supply of it; and the matter dissipated during the combustion is phlogiston neutralized with air: in which state it can only become the *natural food of plants*; for when administered in any other form, it infallibly kills them, unless it is neutralized with water. *Phlogiston* also unites itself with terrene or earthy substances, which are under a *dry* form, and which are much *attenuated*, such as *clays*, to which it adheres with great force, and which, when burnt, makes an excellent manure.

All bodies contain more or less of this wonderful principle; for all bodies become hot by the approach of ignited bodies, and by friction: friction may be therefore said to be a kind of *fire-pump*, that draws phlogiston from the adjoining bodies to the place where the friction is going on; and strongly indicates that phlogiston may lie in a concrete form in, and be a constituent part of all
bodies.

bodies. And the dilatation which this active principle occasions in all bodies, whether solid or fluid, hard or soft, light or heavy, may be esteemed the most certain proofs of its presence and agency.

The great and inexhaustible source of active phlogiston is the *sun*, which gives life and energy to the whole creation; for we evidently observe, that when he returns to us in summer, how his influence animates the whole face of nature, and gives life to millions of animals and vegetables, that have their beginning and ending with the summer's heat: yet heat depends not solely on the rays of the sun, otherwise we should have the same months equally hot and cold at their annual returns; but in part on the vapours and exhalations that arise from the earth, by subterraneous fires, into the atmosphere; which being the receptacle of all kind of forms and solutions, must therefore be universally impregnated with this principle of fire; but so diluted as not to hurt the perspiration of vegetables, nor the respiration of animals. In short, the whole course of nature
would

would be stopped in all its processes without that great and necessary vivifying agent the Sun, whose rays are diluted phlogiston, which is absorbed and neutralized by all bodies, in which it lies in a concrete form, till called forth by combustion or friction.

Rubbing, or friction, in *all* bodies produces *heat* and *electricity*; and both these dilate bodies, help vegetation, germination, and evaporation; accelerate the motion of the blood in animals, and the sap in vegetables.

Phlogiston combined with pure air in a certain proportion constitutes the MATTER of HEAT; and heat, in a moderate degree, contributes materially to promote the growth of plants. It vibrates their parts; excites and promotes a motion in their fluids; prevents moisture from rotting their roots, and their stems from *blights* and *mildews*; resolves the oily and watery particles of the earth into vapour; rarefies their juices; and is the active principle or power which propels them through every vessel of the vegetable body: yet

C

vegetation

vegetation may be injured, either by a defect or an excess of it.

ELECTRICITY and *phlogiston* having so many properties alike, many think them only modifications of the same principle. Iron losing its phlogiston by vitriolic acid, loses by the same process its electricity. This most subtile fluid seems more or less inherent in all matter, and such is the extreme subtilty, velocity, and expansibility of this active principle, that it may with the utmost propriety be called the soul of the universe, which sustains life throughout all nature, as well in animals as in vegetables.

Living vegetables are excellent conductors of this fluid; for if a number of *vegetable capillary syphons* be made to decant water, it will fall from them in *small drops*; but if the water be electrified, it will flow from them in a swift stream. Hence it is found that this fluid accelerates the sap of vegetables, gives and preserves a proper tone in their capillary vessels, increases their perspiration, heightens their verdure, and powerfully promotes

all their secretions. Upon this *principle of heat*, or *phlogiston*, or *electricity*, or by whatever name it may be called, and that of *attraction*, capillary motion and absorption depend. For all parts of matter attract and are attracted, and have a natural tendency to each other; the sides of a capillary tube attract the fluid it contains with greater force than the particles of the fluid attract each other, and water rises above its level against the sides of the bowl that holds it.

Hence it is evident that vegetables conduct their life by receiving this principle by their roots from the earth, and by their leaves and stems from the atmosphere, through the medium of *air* and *water*, which neutralizes and subjects it to the laws of attraction; and after it has passed through all the orders of sap vessels, it then becomes obedient to the laws of vegetation, and forms the bond of union between the parts of the vegetable body; for we see that, upon the abstraction of this principle, the vegetable body is wholly destroyed.

LIGHT is necessary to promote vegetation: for

we know that vegetables languish, grow transparent, and lose their colour in the dark; but, when thus vitiated, are speedily restored by the rays of the sun, which is the principal source of *light* as well as *heat*; and these rays seem to be acted upon by every body in nature, and they may be capable of being combined with air, or water, or earth; and, in that state of combination, they may enter as constituent parts into vegetables, &c. and form airs, salts, and oils of various kinds.

That vegetables imbibe this principle as nourishment, is evident from their parting with it back again into the air, in the act of combustion, or putrefaction; which is but parting with the *inflammable principle* that was a constituent part of them while in health.

The heat of putrescent dunghills, of the fermenting juices of vegetables, and, above all, the spontaneous firing of hay not properly dried, are obvious proofs that vegetables possess this element in great quantities.

II. *Of*

II. *Of* WATER.

THE properties that are common to WATER are various and opposite. It is fluid in a certain degree of heat; solid in a less; and convertible into an elastic vapour of incredible force in a greater. It is capable of dissolving all kinds of salts; of absorbing and detaining in its substance the air of the atmosphere; of being itself absorbed by, and suspended in air. It constitutes the principal part, not only of blood, urine, milk, wines, oils, spirits, and of all fluid bodies; but also enters, in a large proportion, into the constitution of the solid parts of all animal, vegetable, and of many mineral substances. It is capable of being resolved, according to the most recent discoveries, into two sorts of air; and of being transmuted into earth.

Fluids are said to be *perfect* or *imperfect*, as their parts slide with more or less ease over one another; therefore quicksilver is the most perfect of all fluids. Water, being of the imperfect kind,
is

is seldom to be found pure ; for it readily adheres to any substance it meets with, mixes intimately with its particles, and thence becomes impregnated with whatever *strata* it runs over. Hence no water is ever found upon the surface of the earth in a state of perfect purity ; nay, even rain and snow water (which we have particularly in view), although elaborated by the peculiar powers of nature from the most subtile vapours, with a degree of perfection inimitable by art, contain *oily*, *saline*, and *earthy* particles, and are found to be variously contaminated, according to the seasons of the year, the climate, and other circumstances : for it is obvious that these waters, while suspended in the atmosphere, must collect and absorb the various heterogeneous matters with which it abounds, and therefore can never be obtained pure ; but it is in this impure state that they are most serviceable to vegetation.

Various substances are found united with water, and with each other, by means of chemical solution.—The principal of these, as far as they concern vegetation, are now to be enumerated.

That

That water contains *phlogiston* is evident from its state of fluidity; for, when deprived of its natural quantity by the atmospherical cold in winter, it crystallizes, and becomes solid ice; and the particles of water, in shooting out into crystals, recede from their mutual contact with a force capable of overcoming very great resistances: hence water, in freezing, often breaks the vessel that holds it. On this principle we account for the meliorating action of *frost* upon strong moist soils, by expanding and separating their parts. In that view, frost may be considered as a plough superior to any that can be made by the hand of man; for its action reaches the minutest particles of the soil, and the dilatation which it occasions in those particles, renders the soil loose and friable, and disposes it to receive the benign influences of the sun, air, dews, &c. Hence the necessity of winter ploughing, and of exposing the greatest surface possible to the influence of the air.

That water contains *phlogiston* is farther evident from the nature of electricity, for which it
has

has so great an attraction, that the electrical fluid is instantly neutralized with it; and this property is either increased or diminished in proportion to the water's density. Hence *sea water*, when put in motion, collects the electrical fluid more powerfully than fresh water does; and the sea becomes as it were a huge *electrical machine*, when violently agitated by winds, collecting on its troubled surface the fire from beneath, and looking in the night as if it were all in flames.

That AIR abounds in water, is evident from seeing it in water placed in an exhausted receiver of the *air pump*; and also from water which has been purged of its air by being boiled or frozen, re-absorbing as much air from the atmosphere as it had lost. But the quantity of air which water is capable of imbibing and retaining in solution, depends partly upon the temperature of the water, partly upon the weight of the atmosphere, and partly upon the water's purity. According as these obtain, the degree of attraction between water and air is either increased or diminished; and experiment shows, that the quantity of *pure air* contained

contained in most waters is about an eightieth part. The air, moreover, by being absorbed into water, and afterwards separated from it by the action of the sun, to which it is daily exposed, is rendered abundantly more fit for animal respiration than common air ; and this purified air cannot but be one great means of restoring to the whole mass of air, those salubrious qualities of which it is daily deprived, by the *respiration* of animals, the *putrefaction* of bodies, the *combustion* of fuel, and other causes.

FIXED AIR also is found in every water, but in very unequal quantity, from $\frac{1}{100}$ of the bulk of the water, to a bulk equal to that of the water itself. This air communicates to water an agreeable, pungent, and refrigerant flavour, and a sparkling appearance.

That water contains EARTH, is evident from the process of distillation, by the hard crust that is formed upon the inside of boiling vessels ; and from filtration, by the sediment left upon the filtering paper.

D.

SNOW

SNOW WATER contains a small quantity of falited lime, together with some flight vestiges of nitrous acid; this water, when newly melted, is totally void both of *pure* and *fixed air*; substances which are found in greater or less quantity in almost all other waters.

RAIN WATER is generally contaminated with the same substances as the former, but in greater quantity: for while it is suspended in the atmosphere, it absorbs the various heterogeneous matters with which it abounds.

SPRING WATER contains aërated lime, falited lime, common salt, &c.: for, during its passage over, or penetrating strata, it is loaded with heterogeneous matter, more or less according to circumstances; very subtile powders being partly mechanically suspended in it, and partly united intimately with it, in the way of chemical solution.

If water has any thing alkaline in it, the *syrup of violets* turns it *green*; if any thing acid, the *syrup* turns it *red*: if it has run over *iron stone*, or
iron

iron mine, a solution of *galls* turns it *black*; and if *alum*, *oil of tartar* turns it *thick*, &c.—Hence water impregnated with lime-stone, and ouſing flow amongſt moſſes, leaves, &c.—as the water evaporates, the earthy or ſtony matter adheres to theſe ſubſtances, and, aſſuming their ſhapes, gives that variety of whimſical petrefactions we meet with in Derbyſhire, the Dropping Well at Knareſborough, &c.

That vegetables imbibe water as nutrition, is ſeen ocularly when in their recent ſtate, and from their yielding it in large quantities by diſtillation. For all vegetables yield water, impregnated with an acid, and often alſo with a volatile alkaline ſalt; but the quantity and quality of liquids ſeparable from vegetables by diſtillation, varies according to their different natures and ſtates; for green vegetables abound more with liquids than dry ones, and hard ones than ſoft.

Even liquids ſeparable from vegetables in a dry ſtate, by diſtillation, conſiſts partly of oil, but *principally of water* impregnated with an acid,

from which also a volatile alkali may be disengaged ; but the oil varies in quantity according to the nature of the wood ; for the hardest woods, and the hardest parts of the same wood, abound most in oil. The annexed Table shews, at one view, not only the product of liquids obtainable from different woods in a dry state by distillation, but also the other component parts of those woods :

	Heart of Oak.	Box wood.	Mahogany.	Sallow.
Weight distilled -	96 oz.	96 oz.	96 oz.	96 oz.
Liquid - - -	$37\frac{1}{4}$	$61\frac{1}{2}$	$33\frac{1}{2}$	48
Residuum - -	30	$26\frac{1}{2}$	$27\frac{1}{2}$	$20\frac{1}{2}$
Loss of weight -	$28\frac{3}{4}$	8	35	$27\frac{1}{2}$
	96	96	96	96

That part of the oil which is first separated from the woods is so light as to float upon water ; its quantity, however, is but small, compared with that of the thick, black, heavy oil which follows.

The residuum remaining after the distillation of the woods is a *perfect charcoal*, or the earthy part
of

of those woods, which, when burned in the open air, is reduced to a very small quantity.

The matter lost during the distillation is *inflammable air*, which does not begin to be separated from the woods till the lighter of the two oils begins to appear, and then it rushes out with great violence; and this air may be separated from all animal, vegetable, and inflammable mineral substances, by distillation, combustion, and putrefaction.

From the foregoing analysis, we have a comparative view of the proportional quantities of the component parts of vegetable bodies; which are, *water* impregnated with an acid, and often also with a volatile alkaline salt, *air*, *oils* of different colours, weight, and consistences, and a *black coaly residuum*, which is a perfect charcoal, or the *earthy* part of the woods distilled.

From what has been advanced it will appear matter of wonder, that such large quantities of *water*, *oil*, and *air*, should be combined with the
earth

earth of *wood*, by such a peculiar bond of union as to remain for ages, without losing any of their distinguishing properties.

As water is a heterogeneous fluid, it always contains a solution of animal or vegetable substances. These constitute the *natural food* of plants; and the element in which they are minutely suspended, acts not only as a vehicle in guiding them through the fine capillary vessels of the vegetable body, but is also a constituent part of the vegetable body itself: for part of the water adheres so close to the internal solid parts, that it cannot be separated or expelled without a total dissolution or destruction of the vegetable itself.

Hence it is evident, that water is a material principle of vegetation: for, by means of the atmospherical principles, and the mediation of *heat*, it generates earthy, saline, and oily particles; all these are with water imbibed by vegetables, and conveyed to their innermost parts, for their growth and fructification. It is evident, however, that water contains but few nutritive particles;

cles; it was therefore necessary that vegetables should have the power of imbibing a large quantity of it, for the purpose of conveying its most nutritive particles to every part of the vegetable body alike, and of softening the bark and membranes of plants, so that their extension and nutrition may the more easily go on: yet vegetation may be injured, either by a defect or an excess of it.

A want of water injures vegetation, by drying and hardening the earth; which being as it were baked by the rays of the sun, hinders the roots of vegetables from piercing into it in quest of their necessary food, for lack of which they become so dry and hard, that if they are not totally destroyed, their growth at least is greatly checked. For though we have many proofs of the expansive force with which the fibrous roots of plants shoot, yet the less resistance they meet with, the greater progress will they make in equal times. Hence the great use of fallowing, hoeing, manuring, &c. not only as *producing* the food of plants, but of putting the soil into a fit condition for receiving it

it from the atmosphere, and giving easy access to the roots and fibres to extend themselves every way in quest of the same.

The quantity of water which is imbibed by the leaves of vegetables from the atmosphere, as well as that absorbed by their roots, has a great dependence on the moisture of the ground on which they grow; for, when the ground is dry, the air incumbent upon it will, comparatively speaking, be dry also; and the vegetables which grow in that dry air will lack a part of that moisture which is indispensably necessary to their growth and well-being. And it is for want of that moisture in the atmosphere to fill the vessels of the leaves and top branches, that the leaves of corn are observed to grow yellow, and that the early set fruit frequently falls off in the spring, during the continuance of dry, cold north-east winds.

An excess of water injures vegetation, by rendering the earth so loose that the roots of vegetables have no firm holding to support their stems;

by lessening the degree of warmth in the earth, and in their own vessels, which greatly retards the motion of their fluids; by excluding the influences of the sun and air from their roots; by taking off the effect of the mucilage contained in the earth by too great dilution; by forming a crude vitiated thin food, which, though it is productive of the woody part of plants, is yet unfriendly to the impregnation and perfecting of the fruit, which either drops off entirely, or is small and shrivelled: hence it is, that moist seasons do not yield the most plentiful harvests.

Excessive drought, or excessive moisture, an intense cold, or extreme heat, and above all an improper soil, shoot the arrows of certain death to vegetables. Hence the necessity of using our best endeavours to provide against those extremes, by draining, manuring, sheltering, &c.; since it is evident that *heat* and *moisture*, duly combined, are the grand agents of vegetation.

III. *Of* AIR.

AIR is a thin, compressible, and elastic fluid, encompassing the globe of the earth on all sides, and reaches about forty-five miles above the surface of the ground before it degenerates into too thin an ether for any creature to breathe in.

This body of air, together with the clouds and vapours that float in it, is called the atmosphere; which is the receptacle of all sublunary forms and solutions, and the most heterogeneous compound of all fluid bodies. The principles of this compound are now to be enumerated.

FIXED AIR (that wondrous antiseptic) is a permanent and elastic body, composed of earth, water, acids, and phlogiston; and arises from the effervescence of any acid and alkaline mixture, and easiest from chalk and oil of vitriol. All calcareous and alkaline earths and salts contain large quantities of this air, from one-half even to three-fourths of their whole substance:
hence

hence they become excellent manures when mixed with the soil. Liquors, woad, &c. fermenting, discharge plenty of this air; and it is found also in the common atmosphere, where it is as much a constituent part as common air is.

That this air abounds in the atmosphere, is evident from the immense quantities that vegetables receive of it, and from the vast quantities which all caustic calcareous bodies attract of it, upon exposure thereto. A ton of caustic lime will attract from ten to fifteen hundred weight of this air from the atmosphere, according to the degree of purity of the calcareous body from which the lime was produced.

That vegetables imbibe this air as nutrition from the atmosphere, is evident from their giving it back again when under a state of fermentation and putrefaction; for it is absorbed not only by the external vessels of the leaves and bark of vegetables from the atmosphere, but also by their roots from the earth, inasmuch that different

vegetables in their green state contain different quantities of it, from a sixtieth even to one-half of their whole substance: and this air being *one-third heavier* than common air, it gives weight, union, and firmness to all living vegetables. But in their dead or dry state, having lost most of their water in the act of drying, the air then remaining in the vegetable body is by that means decomposed, and changed into *inflammable air*, which then predominates, and becomes the uniting principle; for in distilling dry vegetables we can scarcely detect the presence of any fixed air.

When this air is absorbed into vegetable bodies, it will there become latent and more fixed, as it is capable of being highly concentrated; and when it is let loose by distillation, fermentation, or any acid and alkaline mixture, it gives out its qualities by an acid taste.

Water imbibes this air from the atmosphere, and thence acquires a sparkling appearance, and
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an acidulous taste, and with water it is absorbed by all vegetable bodies.

From the gravity of fixed air it follows, that the lower strata of the atmosphere must abound more with it than the higher; for the prodigious quantity which is generated by fermentation, putrefaction, effervescence, and other natural operations every day going on, for the most part remains close to the surface of the earth: and every fermentation that is raised in the soil, whether by nature or art, sets this air at liberty, which is greedily absorbed by the roots and leaves of vegetables, and in a wonderful manner powerfully promotes their vegetation.

NITROUS AIR is also a compound body, formed of acids, water, and phlogiston; and is produced from the effervescence of any body that contains much phlogiston and the nitrous acid, and easiest from the filings of copper, iron, &c. and the nitrous acid.

That this air abounds in the atmosphere, is evident from the making of salt-petre in different parts of the world, where they expose to the atmosphere rich fat earths, which attract the nitrous spirit of the air, and become impregnated with nitre; and from its being found on old walls, or places impregnated with animal and vegetable juices that have undergone the putrefactive fermentation.

That vegetables imbibe this air as nutrition from the atmosphere, is evident from their giving it back again to the water in which they are boiled, in the form of nitre: the water in which potatoes, spinach, borage, fennel, the sun-flower, tobacco, &c. are boiled, dissolves the nitre they contain; and hence brown paper, soaked in such water, becomes excellent *match* when cut in slips and dried.

INFLAMMABLE AIR, *the pure and elementary phlogiston*, is easiest procured from iron filings and diluted vitriolic acid; the acid seizes the iron, and lets loose the fixed phlogiston, exhibiting it as
elastic

elastic air; and phlogiston, combined with pure air in a certain proportion, constitutes *inflammable air*.

All animal, vegetable, and inflammable mineral substances contain more or less of this air: yet this air is not inflammable of itself, any more than fixed air is effervescent, but is a constituent part of a compound, which being let loose, causes by its flight the phænomenon of inflammation.

The inflammation of coals, candles, wood, paper, pitch, tar, oil, and other combustible bodies, arises from this air being separated from them by heat, and inflamed by the contact of fire, which continues to burn as long as the body continues to afford a proper supply of it: hence we have reason to believe, that this air is the *true elementary phlogiston*, and that it is this gas in a concrete state in coals, candles, wood, metals, &c. that makes them inflammable.

That this air abounds in the atmosphere, is
evident

evident to our senses, in its escape from combustible and putrescent bodies, in the act of combustion and putrefaction, into the atmosphere; and being eight or ten times lighter than common air, it rises from bodies during combustion, bogs, and putrefying substances, into the higher regions of the atmosphere, and, lodging there, frequently receives inflammation from lightning or electricity, giving *thunder* its long progressive sound—*lightning* the property of spreading over the whole hemisphere like a sheet; and when by winds it is drawn into long streaks across the hemisphere, and receives from electricity inflammation at one end, the inflammation runs across the hemisphere, and we call the phenomenon *falling stars*, *meteors*, &c. as that which was seen almost all over Britain on the 18th of August 1783.

In winter there is such a small portion of this air in the atmosphere, that to keep up its own elasticity, it is constantly stealing it from the earth, and from the water upon its surface. Hence it is that water is congealed into ice, and the earth's surface into a hard crust.

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But in summer there is such a redundancy of this air in the atmosphere, that, to keep up the equilibrium, the atmosphere frequently discharges it to the earth, in the form of *lightning*, or *electricity*; and the discharge of this fluid, by the descent of rain that follows it, may be considered as a primary agent in producing the germination of seeds, and the rising of the sap in vegetables: hence vegetables look more vigorous after a thunder-shower than at any other time.

That vegetables imbibe this air as nutrition from the atmosphere, is evident from their inflammability, from their parting with it in the act of combustion or putrefaction, and from their giving out large quantities of it, in the process of distillation, in the form of oil, which can, by a greater force of fire, be converted into *inflammable* air. From whence does a pine growing in the driest sand receive its oily matter? is it not from the atmosphere? Hence we have reason to believe, that this air, in its concrete state, makes a principal part of all vegetable bodies, and is seemingly their great uniting principle; for, upon

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its expulsion from them, they immediately undergo a dissolution.

That WATER abounds in the atmosphere, is strikingly evident, from the immense evaporations of it that are constantly taking place, from the dew on windows, from the wet hair of those who ascend the side of mountains, from its entering sponges when hung in air, &c. From many more proofs it is evident that air is a *menstruum* for water. Air lying on *water*, and rubbing perpetually against it, from this contact, and their natural attraction, the two fluids mutually imbibe one another : and this disposition to unite, seems to indicate their having had a common origin. But the quantity of water which the air is capable of dissolving and suspending, is in proportion to its degree of density ; and this density decreases in a certain ratio, according to its distance from the surface of the earth.

Hence the disposition of the air for dissolving either water, or the matter perspired by vegetables, depends chiefly on its *density*, *heat*, and
7 - *dryness* :

dryness : for the greater the density, heat, and dryness of the air, the more powerful is its action as a menstruum.

Heat assists all solutions, and greatly contributes to the action of all menstrooms upon their solvends ; upon this principle it assists the solvent power of air upon water, by separating its particles and increasing its surface so as to render it specifically lighter than air.

In summer, the action of the air as a menstruum, is rendered so powerful by the increase of heat, that water is immediately and intimately combined with it : for when the particles of water are influenced by heat, and acted upon by a dry, warm air, they easily rise therein, and become soluted in the atmosphere. Hence the quantity of clouds and rain where the sun is vertical, the drying quality of the air in spring, and the rain and fogs in winter ; for summer's warmth assists in filling the air with water, and the winter's cold condenses and brings it down in high latitudes ; and as the higher regions of the air are

cold and thin, the particles of water run together, and form *clouds* about the height of the mountains: the wind, and their own attraction, assist this junction; till their surface becomes so diminished that they precipitate in *drops of rain*. And this ascent and descent of water from and to the earth, is admirably adapted to the great and necessary purposes of preserving animal and vegetable life.

But the water contained in the atmosphere, is not solely raised and suspended by the mediation of *heat*. Strong dry winds, in cold frosty weather, are often more powerful agents in the evaporation of water and other fluids, than the greatest heat of the sun in summer.

The cause of this phænomenon is owing to the small quantity of phlogiston then existing in the atmosphere: for in cold frosty weather the atmosphere is constantly stealing the earth's phlogiston, which carries with it the water with which it is neutralized. Hence it is that evaporation goes forward with great celerity, even in extreme cold
frosty

frosty weather; and the loss which the earth sustains of its phlogiston neutralized with the water thus evaporated, increases the degree of cold on its surface, so as to freeze it into a hard crust.

The quantity of water raised from the earth, and suspended in the atmosphere, is immense. DR. HALLY, by observing the quantity evaporated from a vessel full of water, of the same degree of saltness with that of the ocean, calculated, that the quantity exhaled from the Mediterranean Sea only, in one hot summer's day, there being little wind, amounted to 5,280,000,000 tons of water. And who would have conjectured that an acre of ground, even after having been parched by the heat of the sun in summer, disperses into the air from 1000 to 3000 gallons of water in the space of twelve of the hottest hours of the day?

But a great part of the water which is raised from the perspiration of the earth during a hot day, descends again upon its surface in the course of the night in the form of *dew*; which is greedily absorbed by the vessels of the leaves and
bark

bark of vegetables, from whence it is conveyed to their innermost parts for their growth and fructification. In a hot and dry season this *dew* is particularly serviceable to vegetables, which would otherwise never be able to resist the heat and drought. Hence it is, at one time of the year, that the stems of vegetables do the office of roots, attracting nourishment by their absorbent vessels, the leaves, from the atmosphere.

Water, in ascending from the bosom of the earth, moistens the roots, and by being dissolved in the air, it affords nutriment to the branches of vegetables. But as vegetation may be injured either by a defect or an excess of moisture, and as different plants require different quantities of it, for attaining their utmost perfection; it merits the attentive observation of the farmer, to suit his plants and his manures to the nature of the soil.

That vegetables imbibe water from the atmosphere, is evident from their growing on old walls without earth, and from the known laws of attraction; for the external parts of all vegetables
are

are full of absorbent and perspiratory vessels, which are endowed with a power, inherent in all capillary tubes, of attracting and drawing up the moisture that is applied to their surfaces, and with that moisture every nutritive particle it contains.

When the atmosphere happens to be cold and moist, this absorption takes place ; but when the air is hot and dry, the same vessels throw off the superfluous moisture by perspiration : hence it is evident, that vegetation must be greatly influenced by the state of the atmosphere.

An air absolutely dry, would in a few days annihilate the whole vegetable creation, by exhaling the moisture faster from their stems and branches, than it could be supplied by their roots ; as may be seen from the change which vegetables undergo in extreme hot, or intense cold frosty weather. And an air too full of moisture would in a little time destroy every vegetable by *blights*, *mildews*, &c. But Almighty Providence has provided against these extremes, and in the most wonderful manner

manner preserves a due balance ; for the air is at no time absolutely *cold* and *dry*, nor is it at any time perfectly free from *heat* and *moisture* ; and when a due medium of these obtains, it is most friendly to vegetation. Hence we may conclude, that *heat* and *moisture* duly combined are the grand agents in vegetation ; and on the judicious adjustment of them, as nature has in many instances set the example, the chief art of Husbandry seems to depend.

That the atmosphere is thus compounded, there cannot be the least doubt after what has been advanced ; and that it is most friendly to vegetation in that compound state, is evident from the superior vigour of plants growing in great cities, where the air is so compounded and contaminated, from smoke, putrid effluvia, calcination of metals, breathing and perspiration of animals, as to render it in some degree unfit for human respiration : but Providence has wisely made the *earth*, and the *vegetables* that grow upon its surface, the cure for that evil ; for plants imbibe nourishment from putrid and phlogistic air
by

by their leaves; as may be seen by the superior vigour of plants growing on walls without earth, and by a green plant put in noxious air, which imbibes nourishment, and cures the air at the same time.

Hence it is evident, that the atmosphere is the great repository, the grand magazine, which contains, not only the *fructifying* principles of vegetation, but likewise the *fertilizing* principles of soil. For it is not only the general receptacle of all aqueous vapours, but likewise of all mineral exhalations; of the steams which are constantly arising from the perspiration of whatever enjoys animal or vegetable life, and from the instantaneous putrescence of those substances when deprived of life; of the smaller seeds of terrestrial and aquatic plants; of the eggs of an infinity of species of imperceptible animalcules; of the acids and oils separated by combustion from all sorts of fuel; of the matter of light, of electric effluvia, and of a variety of other substances which are elevated, and for a time kept suspended, in the atmosphere, by natural and accidental

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dental causes ; until they are by the chemistry of nature resolved into new generations, and communicated to the earth again by rain, snow, hail, dew, &c. for the food and nourishment of the vegetable kingdom.

Hence the great use of *fallowing* ; of keeping stiff soils as *rough* and *open* as possible ; and of exposing the *greatest surface* to the influence of the atmosphere : all of which the drill-husbandry ultimately effects.

IV. *Of* EARTH.

EARTHS make up the solid part of our globe ; but they are so intermixed, that it is difficult to come at their component parts.

There are only yet discovered five species of earths, which are so simple that they cannot, by any means hitherto known, be resolved into more simple ones, nor be transmuted one into the other.

These

These are therefore called *primitive* earths, which are,

1st. CALCAREOUS EARTH, *i. e.* chalk, lime-stone, all kinds of marble, various kinds of spar, stactites, sea-shells, corals, coralines, &c. and several other substances which consist of calcareous earth, either *pure*, or mixed with *clay* or *sand*, or other matters, in different proportions; that fall into powder when burnt, and dissolve in the mineral acids.

The constituent parts of *pure* calcareous bodies are, *calcareous matter*, *water*, and *fixed air*; which meeting together in the form of an acid fluid, crystallizes into a solid mass; which is more or less *pure* according to the degree of crystallization, and in proportion to the extraneous matter that is entangled among those crystals.

Experiments show that crude calcareous substances lose about 0.4 of their weight by calcination; but by a slow solution in the acid of sea-salt diluted with water, about 0.45 are lost. Hence it

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appears,

appears, that 100 parts of crude calcareous bodies contain about 40 of fixed air, 55 of pure calcareous matter, and .05 of water, which is necessary to crystallization.

As calcareous substances lose nearly equal portions of their weight, whether they are calcined in the fire, or dissolved in acids; it may be presumed that the matter which is lost is of the same nature in both cases, viz: *fixed air and water*: and the loss of weight is always in proportion to the degree of purity of the calcareous body.

When compact masses of any sort of caustic lime are exposed to the atmosphere, they sooner or later acquire their original weight. Hence it is evident, that the soil upon which quick-lime is spread acquires a great increase of matter, which would not have become united with it without the intervention of lime, whose virtue consists not altogether in its being combined with the soil, but principally in its power of attraction; a power to which all bodies on this globe are found

to be obedient; for the purer any matter, the more powerful is its effort towards an union with other substances: so that calcareous bodies in their caustic state, acting with undiminished force, seize with the greater violence those substances with which they have an affinity, and, if powerful enough, dissolve their former connection; hence they exert a violent acrimony: but as they are gradually saturated, their force becomes weaker, until, a full saturation taking place, all that corrosive faculty vanishes, and can no otherwise be restored than by expelling the saturating matter. Hence it is that quick-lime combined with oils forms soap, &c. By the same property it unites the oily and watery parts of the *soil*; hastens the putrefaction of all the putrescible matter therein, whether animal or vegetable, and converts it into a mucilage, much sooner than it would be otherwise converted; decomposes any aluminous and metallic salts (which are poisonous to plants) that may happen to be in the soil; for the lime will attract the salts and let go the metallic particles, which can do no harm to land unless they are combined with their salts; and it
increases

increases the tenacity of light soils, and the friability of stiff ones.

Crude calcareous substances effervesce violently with the *acid of sea-salt* diluted with water, and are perfectly dissolved therein; and as they lose their air, and are much diminished in weight, it is evident that they undergo as great a decomposition as if they had been calcined in the fire.

Calcined calcareous earth, or lime, may be instantaneously restored to the state of crude calcareous earth, or lime-stone, by adding a solution of salt of tartar, or potash.

This earth (which by itself is infusible), by a sufficient degree of heat, loses about 0.45 of its weight, and the property of effervescing with acids; but it acquires acrimony, solubility in water, and the property of generating heat with it.

2d. PONDEROUS EARTH, *i. e.* calcareous and metallic matter, combined with vitriolic acid and water, forms ponderous earth or spar. It has a
great

great resemblance to calcareous earth; for when exposed alone to the fire, it becomes caustic, soluble in water, and not effervescent in acids; by a sufficient degree of heat, 0.35 of the weight are lost; but, by a slow solution in acids, not more than 0.07 are lost: hence it appears, that 100 parts contain 7 of fixed air, 28 of water, and 65 of pure ponderous earth, consisting of metallic and calcareous matter; which, when combined with diluted vitriolic acid, revives again into ponderous earth.

3d. MURIATIC EARTH, or the EARTH OF MAGNESIA, *i. e.* the powder precipitated from a mixture of Epsom salt, alkali of tartar, or potashes, with water, and evaporated to dryness. Magnesia is an exceeding fine, light, and spongy earth; and therefore the very purest of it, buried in the earth, is soon mixed with other matters, so that it can neither be immediately distinguished, nor often freed from heterogeneous particles, without the help of acid menstrua, in which it dissolves with effervescence.

Although no one has seen thick strata, or huge
2 heap;

heaps of magnesia, yet it is formed in a perfect state upon the surface of the earth, though seldom uncombined with acid substances. The chemical analysis of earths and stones discovers it, partly mixed mechanically with other matters, and partly dissolved.

It is found united with nitrous acid in all nitrous earth, and with marine acid in great quantity in salt springs, and in the water of the ocean; and it is this which occasions the disagreeable bitter taste.

It is found in the very same state in which we have it in the shops, in various mineral waters, as Pyrmont, Spa, and Seltzer, destitute of every acid except the aërial.

Calcined magnesia does not grow sensibly warm with water, nor does it dissolve in it like lime: it is therefore a true earth, so far as can be collected from experiments hitherto made; for in all the experiments hitherto instituted, it preserves the same properties constantly; and analysis shows, that its primary principles are a
peculiar

peculiar kind of earth saturated with fixed air and water: for 100 contains 25 of fixed air, 30 of water, and 45 of pure magnesia: hence it is evident that it is a primary earth, distinct from all others.

Mixed with certain clays, with lime, and siliceous powder, it forms a singular variety of marle.

Ignited alone, it loses its aerial acid, together with the property of effervescing with acids, and becomes insoluble in water.

In sal sodæ it effervesces a little, but is scarcely diminished.

In borax it dissolves with a slight effervescence.

4th. ARGILLACEOUS EARTH—are *clays* that form a tenacious and plastic mass when kneaded with water. They crack when dried, acquire a flinty hardness, contract in the fire, and are used to make porcelain, bricks, &c.; the purest of which

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generally

generally abound with heterogeneous particles, and always contain a considerable quantity of siliceous earth, at least, which generally amounts to half. By common consent, that earth which by mechanical washing, without the addition of an acid, deposits upwards of 70lb. in 100 of siliceous matter, is called argillaceous earth.

Common clay, exposed to a violent heat, gives out a quantity of fixed air several times greater than itself in bulk, mixed with a small portion of inflammable air, which comes off by the first action of the fire.

With fal sodæ it effervesces a little, but is sparingly dissolved.

With borax it dissolves with remarkable effervescence.

And *clay marles*, which consist principally of *clay*, *calcareous* and *siliceous earth*; that moulder in water; that fall into powder by the influence of the air; and that effervesce with acids, especially the

the acid of sea salt diluted with water, in which the calcareous earth contained in the marle is perfectly dissolved; used as a manure, and is of various colours, weights and consistences.

The use of this earth in agriculture depends, in some sort of soils, upon the quantity of calcareous earth it contains, and in others upon the quantity of clay which enters into its composition.

5th. SILICEOUS EARTH, *i. e.* all kinds of sand, gravel, quartz, or pebbles of various colours; mountain crystals, flints, and jaspers; zeoliths, sphaerulites, and garnets; are intermediate between those and gems or precious stones, which are to be entirely excluded from siliceous earths, as not only by their nature, but by the proportion of their primary principles, they challenge a place among the clays, which is the prevalent ingredient. But here we must observe, that the nature of the compound does not always correspond with the quantity of the different ingredients; for the properties of certain simple earths are far more remarkable and intense than those of

others. Thus a mass, in which pure clay makes no more than a fourth, nay even sometimes less, yet preserves the nature and character of clay.

The earth is scarcely ever found pure, at least in the external strata of this globe; but is, like the other primitive earths, more or less mixed with other substances, and that as well mechanically (as is the case in common clay) as by a more intimate connection, and, as it were, solution.

This earth is not acted upon in the usual way by any acid, that of the mineral fluor excepted.

But, when exposed to a violent heat, it dissolves in fixed alkalis with violent effervescence; runs into glass, which is so much the harder, as the siliceous earth, by means of a due degree of heat, constitutes a larger proportion of the whole mass.

It cannot be fused, when alone, by the most violent ordinary fire; but is dissolved by the addition of borax, without effervescence.

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These are all the different species of earths, and are called *primitive*, because they are incapable of decomposition or mutual transmutation by any means hitherto known. Those which are composed of two or more of the primitive earths intimately united, are called *derivative*; of which there are great variety.

Four of the primitive earths are soluble in certain acids; the fifth alone rejects all acids, except that of the mineral fluor. If, therefore, some of these earths, in greater or less number, be united into one mass, chemistry is able to separate them all by the help of appropriated menstrua; on the knowledge of which the analysis of all the different varieties of earths that we meet with on the surface of the globe depends. Nay the component parts of *soil* (which we have particularly in view), although composed of two or more of the primitive earths combined with the other elements, can all be separated by the aid of chemistry.

Take a pound of *soil*, and evaporate it to dry-

ness in a flow heat, the loss of weight will shew the quantity of *common air* and *water* it contained: expose the remainder to a red heat, and the farther loss of weight will give the quantity of *decayed vegetable substances* it possessed, making a little allowance for any acid that might be disengaged by the heat; and the residuum exhibits the quantity of *pure earth* (which may be of various kinds), allowing a little for any alkaline salt that might become fixed in the fire.

Take a pound of *soil*, dry and pulverise it, then pour upon it the acid of sea salt diluted with water; if any effervescence ensues, calcareous earth is one of its elements; when so much acid has been added that no farther effervescence is observed, we may conclude that all the calcareous earth contained in the soil is now dissolved in the acid: filter off the solution, and wash what remains on the filtering paper, by pouring upon it hot water till it is freed from all saline particles; the remainder, being afterwards dried as the pound of soil had been, will shew, by its loss of weight, the quantity of *calcareous earth*

earth which the soil contained: wash the remainder by elutriation in water, which pour off; dry, and weigh the residuum, which will shew the quantity of *siliceous earth*; and the loss of weight, the quantity of *argillaceous earth*.

Boil a pound of *soil* in two quarts of boiled or distilled water, for an hour; let it stand till the earth has subsided; then pour off equal parts of the solution into eight seven-ounce phials, which distinguish by No. 1, 2, 3, &c.

Into the first phial, pour a little *diluted fixt vegetable alkali*; and if there be any earth or metallic salt, a *precipitation* will take place.

Into the second, pour a little of the *syrup of violets*; and if there is any absorbent or alkaline earth, the solution will instantly grow *green*.

Into the third, pour a little of the same *syrup*, or *tincture of turnsole*; and if there be any thing acid, the solution will instantly be turned *red*.

Into

Into the fourth, pour a solution of *galls* in spirit of wine; and if there is any iron, a slow precipitation will take place: if the quantity of metal be small, the precipitate is *purple*; if large, *black*.

Into the fifth, pour a little of the same solution of *galls*; and if there is any copper, the precipitate will be *grey*.

Into the sixth, pour a little of the *oil of tartar*; and if there is any aluminous salt, the solution will instantly grow *thick*.

Into the seventh, pour a little of the *acid of sugar*; and if there is any calcareous earth, it will instantly *precipitate*: and when thus completely separated, that species of earth, which can be afterwards thrown down by *aerated alkali*, is either *magnesia* or *clay*; the former of which dissolves in distilled vinegar, with effervescence; while the latter is taken up slowly, and without any effervescence.

Into

Into the eighth phial pour a little *spirit of wine*, and if there be any salts in the solution, they will instantaneously *crystallize*.

The general properties and criteria of the primary elements being thus defined, it will easily be perceived, that from the decomposition of those elements all other bodies and substances are formed, by *elective* and *corpuscular* attraction. For there are universally throughout nature, principles or powers of attraction which all parts of matter are subject to ; and it is upon this great power of attraction that the decomposition of bodies, and the formation of new ones, depend.

- EARTHS possess this power in an eminent degree, for their attraction of cohesion is stronger than their attraction of gravitation. FLUIDS, on the contrary, have their attraction of gravitation stronger than their attraction of cohesion. It is therefore this attraction of cohesion that makes all bodies cohere, or maintain any distinct form ; and as some parts of matter attract more forcibly than others, earth comes to be heavier than
I * water ;

water ; iron comes to be heavier, and more compact, than wood ; lead is different from stone, because its particles attract one another more forcibly ; gold having more particles in less room than any other metal, is heavier than any other body : so that all the variety which we see in both mineral, animal, and vegetable substances, arises from the different combination of the four elements, the different degree of attraction in the particles of each, and in the different disposition of the pores, or interstices, that are between the particles of which they are composed.

Upon this principle of *attraction*, and that of *phlogiston* or *electricity*, we account for the manner by which plants attract the nutritive juices of the soil by their roots, and the moisture of the atmosphere by their leaves; for the manner by which those juices are secreted; for the rise of the sap in vegetables; for the fertility of soils, and for the whole vegetable economy.

Calcareous, argillaceous, and filiceous earths, combined with water, air, and phlogiston, with
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a small portion of decayed vegetable substances, form within a mere trifle what we call *soil*: these are the great component parts, whatever colour or texture it may happen to have; and according to the prevalent ingredient of which the soil is composed, it takes the name of clayey, marley, stiff loamy, light loamy, gravelly, sandy, chalky, and lime-stone soil: all of which differ very much from one another in their qualities; which is occasioned by the different combination of the primitive earths; and by the different powers and capacities they have of attracting, attenuating, and retaining the other elements.

Between the extremes of *strong clay* and *light sand*, soils vary in every degree with respect to those properties. The attraction between clay and water is the strongest, between sand and water the weakest. But when sand and clay are combined in due proportion, they form an intermediate between these extremes, possessed of all those properties in due quantity; hence it is that such soils are always the richest, as their principles and powers of attraction are most equal and uniform.

Rich fat earths attract the nitrous acid of the air, so as to become impregnated with salt-petre. And caustic calcareous and argillaceous earths, mixed in due proportion to excite a putrefaction in the mass, attract the aerial acid, &c. Hence the use of *fallowing*, and of compounding *lime* and *clay* as a substitute for marle.

Stiff soils retain humidity much longer than light ones; hence the use of *ridging* and *draining* them, to prevent an excess of moisture; which rots the seeds, and likewise the roots of vegetables, especially at the time of flowering; and takes off the effects of the mucilage by too great dilution.

Light soils, on the contrary, are easily robbed of their moisture, and of the small portion of mucilaginous particles they contain; for the scorching heat of the sun upon those soils, soon dissipates them both. Hence the use of *claying*, *marling*, *rolling*, &c. to prevent their escape in the heat of summer.

That the EARTH contains all the other elements,

ments, there cannot be the least doubt. It is the known reservoir of FIRE, of which thunder, earthquakes, volcanoes, &c. are manifest proofs; WATER is its predominant element; and AIR is to be found in every portion of it. In short, it is the receptacle of all the different precipitations that take place in the atmosphere from the alternate vicissitudes thereof, and the womb of all natural conceptions and future generations.

Hence it is evident, that the alternate vicissitudes of the atmosphere are the chief means that NATURE makes use of to fertilize and fructify the earth.

HEAT promotes fermentation, and fermentation divides, attenuates, and subtilizes the earth, by means of an internal motion of its parts, whereby its attractive power and capacity is increased.

COLD fertilizes the earth by the expansive power of the crystallization of the water by *frost*, which breaks down the masses that form in stiff soils,
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and thereby disposes them to receive the benign influences of the sun, air, dews, &c.

RAIN fertilizes the earth by depositing every nutritive particle it contains in the act of filtration, by promoting fermentation through the medium of heat, by dissolving and uniting the oily and saline particles it contains, and by increasing the tenacity of light soils, and the friability of stiff ones.

SNOW fertilizes the soil, by keeping in the internal heat of the earth, by preventing the escape of the other elements; and in melting, it moistens and pulverizes the soil, which had been bound up by the frost; and having a natural tendency to putrefaction, it seems to be admirably fitted to promote the fertility of the earth.

In all these ways NATURE employs the other elements in communicating the food and nourishment of plants to the earth; in which respect her economy is transcendently beautiful and astonishing,

ing, and loudly proclaims the wisdom and goodness of Providence, in making the earth, and the vegetables that grow upon its surface, the means of keeping the common air fit for breathing.

From what has been advanced it will appear abundantly evident, that, from a due combination of the four elements, a number of different fluids are formed and imbibed by vegetables. And it is highly probable, that the radical fibres of plants, after being properly dispersed and covered in the soil, take up the nourishment that is applied to their surfaces from the earth and atmosphere, in the same manner that the lacteal vessels absorb the nutriment from the stomach and intestines of animals.

A *placenta* and an *umbilical chord* are by all thought essential to elaborate and administer the nutritive fluid to the *fœtus* in the womb, and to produce an extension of its parts; and since the cotyledons of plants, which include the *corculum* or first principle of the future plant, with which they communicate by means of tubes branched
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out into infinite ramifications, are wholly analogous to the placenta and umbilical chord of animals, we have great reason to suppose that the embryo plant, and the embryo animal, are nourished and dilated in their dimensions after the same way.

For the roots and stems of all vegetables are pierced with innumerable small bibulous orifices, by which the nutritive juices of the earth and atmosphere are absorbed into their capillary vessels; through which they ascend upwards by an inherent power of attraction and absorption, common to all capillary tubes, and natural to the living powers of vegetables, which are so adjusted to one another as to accomplish in perfection the end which the Author of Nature designed them for. Those juices, in their passage upwards, receive some degree of melioration from the different orders of sap vessels, until they get into the wood, or flesh, where they receive their last degree of concoction, previous to their being assimilated into the nourishment of the respective parts of the vegetable body.

LIGHT,

Light, heat, and air, all conspire to draw the sap to the top of the leaves and branches of vegetables, where the watery particles are perspired off in the form of vapour, while the more nutritive particles adhere to the extremities of the leaves and buds, and thereby gradually dilate every part of them, until they are extended to their full length.

During the heat of a summer's day, the juices are highly rarefied, and, by the attractive power inherent in all capillary tubes, by the mutual attraction between the constituent parts of vegetables, and by the perspiration constantly going on from the superior parts of their vessels, are raised from the roots of the plants to the extremity of their branches; but as the solar heat declines, the juices condense, and fall down in the manner of the spirits of a thermometer. This alternate ascent and descent of the juices varies according to the degree of heat in the atmosphere; which continually varying, the motion of the sap must be sometimes quick and sometimes slow, according to the temperature of the atmosphere.

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All

All plants were originally created of many species, and each species was endowed with powers peculiar to itself, to produce its own likeness; by which powers the species are uniformly preserved distinct from one another; each having their sexes, propensities, season of copulation, and pregnancy consequent thereon.

This specific difference is doubtless owing to climate, and to the very different structure of their capillary vessels; whereby an almost infinite variety of combinations and modifications of the common principles of vegetables are formed.

Matter, considered as matter, has no share in the quality of vegetable bodies; for in whatever manner the particles of matter are formed into an organic body, of which we know little, yet one thing we know, that the organic body acquires a nature very different from its constituent particles. The sweet, bitter, and aromatic juices of vegetables; the blood, bile, urine, fat, and bones of animals, are all very different from the substances of which they are composed; it is therefore
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from the transmutation of matter by vegetable secretion that we have so many distinct species. It is from the configuration of the vascular system, through which nutrition is conveyed to every part of a plant, that the external figure is derived: and from the same configuration the internal properties seem to arise; for plants become acescent or alcalescent, sweet or bitter, poisonous or salubrious, according to their different natures, though they be planted in the same soil, and fed with the same food; that being changed and elaborated, by processes which we can neither understand nor imitate, into different fluids, by the different organizations and powers of different plants.

In a fecundated germ, the little body, the rudiment of the future foetus, lies wholly concealed, until by proper heat and nourishment it is gradually evolved, increases, and arrives at maturity. In all organic bodies, therefore, the form is predetermined from their origin, which the power of their internal and peculiar structure is calculated to develope.

But after all that can be said, I am truly sensible that vegetable life and increase cannot be accounted for, without recurring to the adorable Author of Nature as the primary cause of both. We have fruitful seasons, but we know not the cause by which the vapours are raised from the earth, or poured down in rain from heaven; nor can the most recondite philosophy account for the germination, or maturation, of a single grain.

Yet a proper knowledge of the basis of agriculture will enable the husbandman to practise that art in such a manner as to reap all the advantages that can be derived from it; to be satisfied of the reasonableness of the method of his proceedings; and it will likewise help to direct his operations in doubtful cases.

C H A P. II.

On the shape and size of the roots of such plants as are the objects of field-husbandry.

WITHOUT a knowledge of the shape and size of the roots of such plants as are the objects of field-culture, it is impossible for the husbandman to have any adequate idea of vegetation.

But when he once becomes acquainted with the nature and structure of the roots of those plants, he will find himself rationally instructed in the manner of cultivating them to the greatest advantage, by following the bias of nature, in suiting his plants to the nature and culture of his soil; and will likewise be enabled to direct the variation of his crops, upon just and rational principles.

As wheat is the most valuable, as well as the most serviceable grain to mankind, it demands our first attention.

WHEAT has two sets of roots. The first comes immediately from the grain at the same time that the germ does, and is called the *seminal root*; which, together with the farina, nourishes the plant until it has formed its crown, which it always does just within the surface, where the soil is the richest, whether the grain has been sown deep or superficial. The other shoots from the crown some time in March or April, according to the temperature of the weather, and is called the *coronal root*. A small pipe preserves the communication between them; on the proper length of which, and the vigorous absorption of the coronal roots, the goodness of the crop depends. And as both sets of roots are tender and fibrous, they require land to be in fine tilth.

Plants, according to their species, observe a regular uniformity in the manner of spreading their roots. Some keep near the surface, others
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go deeper into the ground. Wheat being subject to the severity of winter frosts, its roots are wonderfully disposed to withstand the inclemency of the season. For the *feminal* root not only nourishes the plant until it has formed its crown, but also serves the purposes of an anchor, and prevents the winter's frost from ejecting it out of the ground; and being out of the reach of the frost itself, it is the more enabled to send up plenty of nourishment to the crown, by means of the pipe of communication.

When the crown has become sufficiently large, it detaches a number of strong fibres, which push themselves obliquely downwards. These are the coronal roots, which are of vast importance to the crop, as they give the stalks stability and food, even when the severities of winter have well nigh demolished the feminal roots. The first they effect, by diverging from the crown to the land at the best angle their situation admits of; and thereby proping themselves, and sustaining their position: the latter by directing their minute ramifications through that part of the surface

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which the feminal roots had not exhausted, and where the most immediate and powerful influence of the sun and air obtains. Hence the reason of wheat all on a sudden, in the spring, after there has been some mild weather, getting such a deep green colour, broad leaf, &c.

Those leaves at that season protect the coronal roots from the inconvenience of approaching droughts, and by their keeping near the surface they are enabled to escape the ill effects of too much moisture.

As the coronal roots increase in size and vigour, they push themselves deeper into the earth, from whence they draw such nutritive particles as it contains; at the same time they send up a numerous set of stalks. This is called *tillering*, which principally depends upon the vigorous absorption of the coronal roots; and those stalks being of a succulent nature, attract from the atmosphere such nutritive particles as their tender vessels are fit to convey.

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After this, *nature* furnishes, at small distances, the stems with a number of joints and leafy spires, which draw nourishment from the roots, as well as attract and imbibe it from the atmosphere. As the plant advances in stature, a much greater quantity of nourishment is necessary, in proportion to its greater increase : which supply nature daily increases by the greater expansion of the roots and leaves. The former absorb in greater plenty the nutritive juices of the soil, while the latter attract and imbibe the nutritive particles of the atmosphere ; until, by the dilatation and extension of all its parts, the work of vegetation is completed, by the nearer and nearer union of its principles and parts, which become more and more firmly compacted into hard substances as the watery particles fly off, and as it approaches towards a state of maturity.

BARLEY has likewise two sets of fibrous roots ; the first comes immediately from the grain, and is called the *seminal root* ; the other forms itself in a few weeks after sowing, and is called the *coronal root*. A small pipe preserves the communication

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between them. And as the roots of barley are more tender and fibrous than those of any other kind of grain, they require a finer tilth. As barley has not to withstand the severities of winter, the distance between the two roots need never exceed two inches, nor should ever be less than one. At these distances the seminal roots will be out of the reach of common droughts, and will thereby be enabled to send up plenty of nourishment to the crown, which always forms itself just within the surface of the ground; and later or sooner after the seed has been sown, according to the temperature of the weather, the crown pushes out a vast number of lateral fibres, and at the same time sends up a numerous set of stalks. This is called *tillering*, and principally depends upon the vigorous absorption of the coronal roots: hence the necessity of attending to whatever may promote and succour them.

Sowing rape dust, foot, pigeons' dung, ashes, salt, &c. invigorates the roots of spring corn, and greatly recovers winter corn from the injuries
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it may have received from the ill effects of frost, when harrowed and rolled in.

OATS have also two sets of fibrous roots, which are strong and piercing; they are therefore formed by nature to seek their passage through land but imperfectly tilled, which accounts for the excellent crops of that grain produced upon a single ploughing; though two ploughings would repay the farmer well for his labour, and would also give a check to the growth of many weeds, which, when suffered to grow, not only rob the ground, and starve the good grain, but also prevent a free circulation of air about the roots and stems of the growing crop, which is a great impediment to vegetation.

BEANS are tap-rooted. Assisted by their wedge-like form, they pierce through the strongest soils. A bean consists of two lobes, between which the embryo plant is securely lodged. In a few days after it has been committed to the earth, according to the temperature of the weather, &c. these lobes begin to separate, and disclose to the naked

eye the root, which, being sharp and pointed, seeks a passage downwards, and fixes itself in the soil. After this, the germ with its leaves may plainly be discovered seeking a passage upwards. As the germ increases in size, the lobes are further separated; and the tender leaves, being closely joined, push themselves forwards in the form of a wedge. As soon as they have reached the surface, they lay aside their wedge-like form, and spread themselves in a horizontal direction to catch the moisture of the atmosphere.

The root every hour increasing in size and vigour, pushes itself deeper into the earth; from which it attracts such nutritive juices as it contains, while the leaves at the same time attract and imbibe the nutritive principles contained in the atmosphere.

As the stems advance in stature, nature furnishes them more and more with leaves, which, being of a succulent nature, draw the greatest part of their nourishment from the air. Hence it is evident that beans impoverish the soil less than

wheat, barley, oats, or rye, whose leaves are of a firmer texture, and consequently receive less of their food from the atmosphere : for beans, in a healthy and vigorous state, will, by the *umbrageous* defence of their thick leaves and stems, sufficiently protect their roots, which go deep into the ground, from the too scorching rays of the sun ; and even retain a due degree of moisture in the ground, without excluding so much of his *energetic* power as is necessary for perfecting the great work of vegetation. Under these circumstances, beans are considered as an ameliorating crop.

When beans are sown too thick, they push themselves upward with seeming vigour, and the crop has the appearance of being a good one ; but, when examined, we find the pods small, and few in number. On the contrary, when sown in drills, with proper intervals, and a due quantity of seed, the straw is shorter, and the pods much larger and more numerous ; so that a drilled crop of beans is always superior to a crop sown by the hand.

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As soon as the grain is properly formed in the pod, the leaves begin to lose their succulency, and diminish in their attracting powers; consequently the plant depends more upon the absorption of the radical fibres, which are then vigorously employed in extracting the nutritive juices of the soil, for the nourishing and perfecting of the seed, until the work of vegetation is completed.

PEASE, having a fibrous and tender root, which goes pretty deep into the ground, require a dryer, warmer, and lighter soil than beans. From the great succulency of their leaves and stems, their roots require to be at a pretty good distance from one another; for when they are too near, on rich soils, the stems are elevated beyond that pitch to which the soil ought to raise them, and the real nourishment that should go to the grain is spent upon the straw; but when they are sown in drills, with proper intervals, the straw is stronger, and the pods much larger and more numerous. From their great succulency, they draw most part of their nourishment from the air, and on that account impoverish the soil less than plants of the culmiferous kind.

TURNIPS

TURNIPS have two kinds of roots. The first comes immediately from the seed, and is tender and fibrous : it therefore requires the finest tilth. As the turnip increases in size, it acquires a tap-root with horizontal fibres, which go deep into the ground, and by which the plant is principally nourished ; hence the necessity of frequent and deep ploughings, to give easy access to the roots and fibres to extend themselves every way in quest of food.

The leaves of turnips are very succulent, and the tuberous roots, in some soils, grow to a great size : hence the necessity of planting them at a proper distance, which need never exceed twelve inches, nor should it ever be less than eight, upon any soil.

In light soils, turnips are the basis of agriculture ; hence the necessity of attending to whatever may promote their growth, and succour them against the depredations of the fly.

A turnip seed consists of an external covering, or husk, and two lobes, which constitute the body
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of the seed. These lobes form the feminal leaves, which contain all the oil of the seed, which, when diluted by the moisture of the atmosphere, constitutes an emulsion for the nourishment of the plant. The sweetness of this balmy fluid invites the devouring fly, against which no sufficient remedy has yet been discovered.

The best preservative against that devouring insect is to prepare the land thoroughly, and to steep the seed in train oil for twelve hours; after that, drain off the oil through a fine sieve, and then add a quantity of sulphur sufficient to crust the seed all over, that it may not flick together.

Turnip seed thus prepared, and sown about one inch deep, will seldom disappoint the expectations of the farmer. For the lobes, which constitute the body of the seed, and which likewise form the feminal leaves, will be so strongly impregnated with the essence of the ingredients with which they have been mixed, as to render the effluvia of the leaves so disagreeable as to baffle the attacks of the fly.

RAPE

RAPE and COLE-SEED have two kinds of roots. The first comes immediately from the seed, and is tender and fibrous; they therefore require a fine tilth. As the plant increases in size, it acquires a long slender tap-root, sometimes branching out into three or four: hence the necessity of frequent and deep ploughings. And as rape is an oil-bearing plant, it requires a rich mellow soil.

The leaves of this plant are very succulent; and hence the necessity of allowing a proper distance between each, to admit a free circulation of air, from which the leaves draw most part of their nourishment; and that distance need never exceed fifteen inches, nor should ever be less than ten, upon any kind of soil.

CARROTS have a long, thick tap-root, with horizontal fibres; they therefore require a deep, rich, and dry soil, which must be brought into a fine deep tilth, to give a free passage for the roots to strike downwards according to the direction of nature, as the value of the crops depends upon their length and thickness.

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The root of the carrot is long and thick, varying in colour from the deepest orange to the palest straw. The leaves are large, and divided very beautifully into a multitude of minute parts. Hence the necessity of planting them at a proper distance, which need never exceed fifteen inches, nor should ever be less than ten, upon any soil.

There are several other sorts of plants that are raised by the husbandman; but those I have enumerated will be sufficient to show him the necessity of attending to the bias of nature in all the operations of husbandry, in suiting his plants to the nature of the soil.

It is from an attention to the nature and structure of the roots of plants, that I have been convinced of the necessity of placing their seeds at a certain depth and distance in the earth, in order to their producing vigorous and healthful stems.

In winter corn, the plant is nourished during the severe months by the *feminal root* only. The seed therefore should be planted pretty deep, that the feminal root may not only be able to

send up plenty of nourishment to the crown, but also to serve the purpose of an anchor to secure the plant against the ill effects of frost. On this account drilled wheat stands the winter better than the broad-cast. Hence it is obvious, that wheat sown superficially must be exposed to the severity of the winter's frost, from the shortness of the pipe of communication between the two roots. The plant, in that situation, has no benefit from its double root : on the contrary, when the grain has been planted at a proper depth, the two roots are kept at a proper distance ; and the crown being well nourished during the winter, throws off a number of fresh roots, and at the same time sends up a numerous set of stalks in the spring. Soon after this, the seminal root dies, and the plant is then nourished by its coronal root : hence the necessity of planting the seed at a proper distance, to give the coronal roots room to spread themselves according to the direction of nature, and to admit a free circulation of air, so as to acquire strength and stability to collect a sufficient quantity of food to support a healthy vegetation in the stalks, &c. For if the roots

of one plant are so near as to twist in all directions round the roots of another, they will both be unavoidably injured, as the contact occasions a contraction of the tubes or vessels, and likewise galls their surfaces; which wounds are exceedingly hurtful to the growth of plants. Hence it is evident that all kinds of grain and feed should be planted at a proper distance, and that distance ought at least to be equal to twice the length of the roots and branches that any kind of plant will extend to.

Pure air is necessary for animals, and vegetables cannot live without fresh supplies of it. When plants stand too thick, they are obliged to breathe their own stagnant vapours, and become unhealthy: the stems run out to a great length on a rich soil, are exceeding small and weak; the leaves endeavour to spread out to a great distance, the proper juices are not formed by secretion, little or no impregnation takes place in the flowers, and the whole plant, if not destroyed, is of little use. Hence the necessity of depositing all kinds of seed at a proper distance to admit a
free

free circulation of air: and as the roots of plants require air as well as the stems, hence the necessity of attending to the depth in depositing the seed, as well as the distance. The superior goodness of grain produced by the drill-husbandry depends greatly on these two circumstances: because, in the first instance, the sun and air have free access to the stems; and in the second, the earth lies light and easy upon the spreading roots, fitly disposed to receive the benign influences of the sun, air, dews, &c. than which nothing is more absolutely necessary to invigorate and promote the growth of plants. What that depth and distance should be, depends in a great measure on the season, and on the condition and culture of the soil. Every occupier of land must therefore experiment for himself, if he rationally expects to acquire proper information relative to this important matter.

My experiments show, that about three inches is the best depth for beans and pease, two inches and a half for wheat and rye, two for barley and oats, and about one for carrots, turnip,

and rape seed, &c. When I say *about*, I only mean that these depths should neither be much exceeded nor abated; but in light soils, and dry seasons, the greatest depths should be used. In good rich soils, I have always found those depths the best, and about eight or nine inches between the rows the most proper distance, for a full crop of wheat, rye, barley and oats.

Beans and pease, being very succulent plants, require a greater distance between the rows, in order to admit, not only a free circulation of air, but also to give room for the easy introduction of the horse-hoe; and the most proper distance I have always found to be from 24 to 30 inches between the rows.

Turnips, carrots, rape-seed, &c. require nearly the same distance between the rows, which need never exceed 14 inches, nor should ever be less than eight, upon any soil where a full and profitable crop is expected; but in rich soils, and moist seasons, the greatest distances should be used.

C H A P.

C H A P. III.

*On the superior Advantages of the Drill to the
Broad-cast Husbandry.*

IN the broad-cast husbandry, the land is often sown in bad tilth, with more than double the quantity of seed that is necessary; which is always scattered at random, and sometimes by very unskilful hands.

In some places the seed falls too thick, in which case the plants have no room or strength to tillure, the stems will be few and weak, and the crop liable to be beat down and spoiled by bad weather; in other places it falls too thin, in which case weeds will spring up instead of corn, so that the farmer will manure his soil and waste his labour for little profit: and the seed being but imperfectly covered by the harrow, a part of it is destroyed by vermin which follow
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the fower ; another part is exposed, on the surface of the ground, to rain, drought, and frost, which if they do not destroy, greatly injure it.

When the seed is harrowed in, it is placed at unequal depths ; the seed consequently sprout at different times, and produce an unequal crop ; an accident to which barley is particularly liable. And if the roots are buried too deep, the cheering and vivifying powers of the sun and air are so impeded in exerting their necessary influences, that the roots never arrive at perfection : which brings on a premature ripeness, and instead of good corn, the farmer only gets a crop of straw and light corn.

In the broad-cast method, the soil cannot be hoed nor stirred to give more nourishment to the plants ; nor can even the weeds be destroyed, without much expence, and injury to the growing crop.

The drill-husbandry overcomes all those difficulties and disadvantages. The land is made finer by frequent ploughings and harrowings, and the

the seed being planted at proper and equal depths, gives the farmer a full command over the seasons whether they are wet or dry, and secures an equal and clean crop in all circumstances of the weather. It saves more than one third of the seed which is used in the broad-cast method; deposits it at equal depths, suited to the nature of each kind of seed; distributes it at equal distances; and by being equally and speedily covered, it is protected from vermin and other injuries. It gives the husbandman an opportunity of horse and hand-hoeing his land, which almost totally destroys the weeds, without injuring the growing crop; and gives the roots of plants liberty to extend themselves in search of their necessary food, so that they have the full advantage of all the soil's fertility.

By the frequent stirrings and hoeings, the plants *tillure* more; the rains, dews, &c. are more freely imbibed by the well pulverized soil; and the aliment which they contain is directly conveyed to the roots and fibres of the plants which grow upon it; by which means the land is so much fertilized, that it is half prepared for a succeeding crop.

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The intervals between the rows give due admission to a free circulation of air, which is absolutely necessary to promote a vigorous vegetation. In consequence of this freedom of air, upon which I lay great stress, the ears of corn are always observed to be well fed, and the stalks firm and strong, and abler to stand against the storms of wind and rain. Hence it is evident, that the chief instrument which *nature* makes use of to fructify the earth, and furnish the pabulum of plants, is the atmosphere, which is the great fund or magazine of all the principles of vegetation; and it is from that great and inexhaustible source that the fertility of the earth is derived, of which fallowing is a manifest proof. But pulverization is absolutely necessary to prepare the soil for the reception of those particles; for earth, in its natural compact state, admits neither rain, dew, snow, nor any of those finer and more subtilized particles which are continually floating in the atmosphere, descend with them to the earth, and are carried off with them in the streams they form on the surface, together with such other particles as they take up and arrest in their way.

In this respect *nature* is particularly assisted by the drill-husbandry, which breaks, divides, and pulverizes the soil, so as to prepare it for the easy entrance of those fertilizing principles with which the atmosphere abounds.

Hence it is evident, that the advantages of the drill-husbandry are very great, and that it is far superior to the broad-cast method, whether it is considered as connected with the horse-hoe, or only for sowing the land in equidistant rows.

But the following comparative experiments will set the advantages of the *drill* above the *broad-cast husbandry* in so clear a point of view that he that runs may read.

In the year 1783, I began those experiments upon various kinds of soil, and in every one of them I employed two acres of land, laid up in eleven feet ridges, and drilled and sown broad-cast alternately.

Experiments on Oats.

The soil a hazel-coloured stiff loam, worth twenty shillings per acre.

<i>Drilled Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1783.				
Mar. 6.	To ploughing it up from swarth		5	
10.	To five harrowings and 1 rolling at 6d.		3	
	To drilling the seed 2 In. deep and 8 asunder			6
	To harrowing after			6
	To 12 pecks of seed at 9d.		9	
April 20.	To rolling			6
May 14.	To breast-hoeing, 1st time		2	
June 5.	To ditto 2d time		2	
	To hand-hoeing		1	6
	To 1 year's rent, &c.	1	1	
		2	5	0
<i>Contra</i>		<i>Cr.</i>		
Sept. 19.	By produce of the crop, 56 bushels at 2s. 3d.			
	per bushel	6	6	
		4	1	0
		Clear profit		

Expe-

Experiments on Oats.

<i>Broad-cast Acre</i>		<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1783.					
Mar. 6.	To ploughing up from swarth			5	
10.	To 8 harrowings at 6d.			4	
	To seed for 16 pecks at 9d.		1	2	
	To sowing ditto				3
April 20.	To rolling				6
May 24.	To hand-weeding 1st time			2	6
June 15.	To hand ditto 2d time			3	
	To rent, &c.		1	1	
			2	8	3
<i>Contra</i>		<i>Cr.</i>			
Sept. 19.	By produce for 50 bushels, 2s. 2½d.		5	6	3
		Clear profit	2	18	0
By gain in favour of the drilled crop			1	3	0
			4	1	0

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Experiments on Cole Seed.

After the Oats.

	<i>Drilled Acre</i>	<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1783.					
Nov. 4.	To ploughing the lands across, 5 inches deep			5	
1784.					
Mar. 1.	To break harrowing 1st time	.....		1	6
26.	To ploughing the 2d time	.....		5	
April 24.	To break harrowing 2d time	.....		1	
	To harrowing and rolling	.....		1	
May 16.	To ploughing the land 3d time	.....		4	
30.	To 4 chalders of lime at 10s ($\frac{1}{2}$ charged)		1		
	To drag harrowing	.....		1	6
June 12.	To rolling and harrowing	.....		1	
28.	To ploughing 4th time	.....		4	
	To harrowing and rolling ditto twice	.....		2	
29.	To drilling every other land 1 In. deep 12 afund.				6
	To feed, for $\frac{1}{4}$ of a peck	.....			6
	To harrowing ditto	.....			6
July 24.	To hoeing the first time (breast hoe)			2	6
Aug. 16.	To hoeing 2d time, ditto	.....		2	
	To 1 year's rent, &c.	.....	1	1	
		Expences	3	13	0
	<i>Contra</i>	<i>Cr.</i>			
Nov. 24.	By value of the crop appraised	.....	4	0	0
		Clear profit	0	7	0

Expe-

Experiments on Cole Seed.

After the Oats.

<i>Broad-cast Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1784.	To 4 ploughings		18	
	To 6 harrowings		3	
	To 2 rollings		1	
	To 4 chalders of lime (charged $\frac{1}{2}$)	1		
June 28.	To sowing every other land			3
	To seed, for $\frac{1}{4}$ of a peck			6
	To harrowing ditto			6
	To rolling			6
July 10.	To harrowing the crop			6
18.	To hoeing the 1st time		3	0
Aug. 12.	To hoeing 2d time		2	6
	To 1 year's rent, &c.	1	1	
		Expences	3	10 9
<i>Contra</i>		<i>Cr.</i>		
Nov. 24.	By value of the crop appraised	3	16	0
		Clear profit	0	5 3
		By gain in favour of the drilled crop	0	1 9

Expe-

Experiments on Barley.

After the Cole Seed.

<i>Drilled Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1784.				
Dec. 24.	To ploughing the land 1st time		5	
1785.	To half the charge of the lime	1	8	
Mar. 20.	To break harrowing the land		1	
April 1.	To ploughing the land 2d time		4	
	To harrowing ditto 3 times, and rolling		2	
	To drilling the seed 2 inches by 9 inches			6
	To harrowing ditto			6
	To seed for 8 pecks at 9d.		6	
	To rolling			6
May 10.	To breast-hoeing the 1st time		2	
	To hand-weeding the rows		1	
June 4.	To breast-hoeing the 2d time		1	6
	To hand-weeding the rows		1	
	To 1 year's rent, &c.	1	1	
		Expences		
		3	4	0
		<i>Cr.</i>		
Aug. 20.	The whole was reaped, and in a few days was housed, threshed, and produced 58 bushels at 3s.	8	14	0
		Clear profit		
		5	10	0

Expe-

Experiments on Barley.

After the Cole Seed.

<i>Broad-cast Acre.</i>		<i>Dr.</i>		
		£.	s.	d.
1784.				
Dec. 24.	To ploughing the 1st time		5	
1785.	To half the charge of the lime		18	
Mar. 20.	To break harrowing the land		1	
April 1.	To ploughing the land 2d time		4	
	To sowing the seed			3
	To seed for 12 pecks at 9d		12	
	To harrowing ditto 4 times		2	
	To rolling ditto			6
May 10.	To hand hoeing the 1st time		2	6
June 4.	To hand weeding the 2d time		2	
	To rent, &c. for 1 year	1	1	
		Expences		
		3	8	3
		<i>Cr.</i>		
Aug. 26.	The whole was reaped, and in a few days was housed, thrashed, and produced 51 bushels at 3s	7	13	
		Clear profit		
		4	4	9
		1	5	3
		5	10	

Experiments on Beans.

After the Barley.

		<i>Drilled Acre.</i>	<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1785.						
Nov.	4.	To ploughing the land 1st time	.....		5	
1786.						
Mar.	6.	To break harrowing	.....		1	
	8.	To ploughing 2d time	.....		4	
		To 4 harrowings at 6d	.....		2	
		To rolling	.....			6
		To drilling the feed 3 by 24 inches	.....			6
		To harrowing ditto	.....			6
		To seed for 8 pecks at 10½d.	.....		7	
April	20.	To rolling	.....			6
		To harrowing	.....			6
May	16.	To horse hoeing 1st time	.....		1	
	20.	To hand hoeing the rows	.....		1	6
June	16.	To horse hoeing the intervals 2d.	.....		1	
	18.	To hand hoeing the rows	.....		1	6
	26.	To earthing up ditto 1st time	.....		1	
July	10.	To earthing up ditto 2d time	.....		1	
		To rent, &c.	.....	1	1	
			Expences	2	9	6
		<i>Contra</i>	<i>Cr.</i>			
Sept.	29.	By produce for 36 bushels 3s 6d	....	6	6	
			Clear profit	3	16	6

Expe-

Experiments on Beans.

After the Barley.

<i>Broad-cast Acre.</i>		<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1785.					
Nov. 4.	To ploughing the 1st time	.....		5	
1786.					
March 4.	To break harrowing	.....		1	
8.	To ploughing the 2d time	.....		4	
	To sowing the seed	.....			3
	To harrowing ditto 5 times	.....		2	6
	To seed for 12 pecks at 10 ¹ / ₂ d.	.....	10	6	
April 20.	To rolling and harrowing	.....		1	
May 29.	To hand weeding 1st time	.....		3	
June 30.	To ditto 2d time	.....		1	6
	To rent, &c.	.....	1	1	
		Expences	2	9	9
<i>Contra</i>		<i>Cr.</i>			
Sept. 29.	By produce for 30 bushels 3s 6d	.....	5	5	
		Clear profit	2	15	3
		By gain in favour of the drilled acre	1	1	3
			3	16	6

Experiments on Wheat.

After the Beans.

		<i>Drilled Acre.</i>	<i>Dr.</i>		
			£.	s.	d.
1786.					
Sept.	18.	To ploughing the land 1st time		5	
Oct.	6.	To break harrowing ditto		1	
		To gathering the weeds off		2	
	8.	To ploughing the land 2d time		4	
		To harrowing ditto thrice and 1 rolling		2	
		To drilling every other land $\frac{1}{2}$ by $\frac{1}{8}$			6
		To seed for 7 pecks at 16d per peck		9	4
1787.		To harrowing ditto			6
April	20.	To rolling and harrowing for 1st weeding		1	
May	6.	To hoeing the intervals 1st time		2	
		To hand weeding the rows		1	
	30.	To hoeing 2d time		1	6
June	4.	To hand weeding the rows		1	
		To 1 year's rent, &c.	1	1	
			Expences		
			2	11	10
		<i>Contra</i>	<i>Cr.</i>		
Aug.	24.	By produce for 36 bushels at 5s 6d	9	18	
			Clear profit		
			7	6	2

Expe-

Experiments on Wheat.

After the Beans.

<i>Broad-cast Acre.</i>		<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1786.					
Sept. 28.	To ploughing 1st time	.....		5	
Oct. 6.	To break harrowing	.....		1	
	To gathering the weeds off	.....		2	
	8. To ploughing 2d time	.....		4	
	To seed for 9 pecks 1s 4d.	.....	12		
	To sowing ditto	.....			3
1787.	To harrowing 5 times	.....		2	6
April 20.	To rolling and harrowing 1st weeding			1	
May 14.	To hand weeding 1st time	.....		2	6
June 12.	To hand weeding 2d time	.....		2	
	To 1 year's rent, &c.	.....	1	1	
		Expences	2	13	3
		<i>Cr.</i>			
Aug. 26.	By produce for 30 bushels 5s 6d	.....	8	5	
		Clear profit	5	11	9
		By gain in favour of drilled crop	1	14	5
			7	6	2

Expe-

Experiments on Turnips.

The soil a light sandy loam worth about eighteen shillings per acre.

		<i>Drilled Acre.</i>	<i>Dr.</i>		
			£.	s.	d.
1789.					
Feb.	11.	To ploughing the 1st time		5	
	31.	To break harrowing		1	
April	28.	To ploughing the 2d time		4	6
May	10.	To harrowing twice		1	
		To gathering the couch grafs off		2	6
	24.	To 10 loads of rotten dung (charged $\frac{1}{2}$)	12	6	
		To ploughing the 3d time		4	
		To rolling			6
June	16.	To harrowing twice		1	
		To rolling			6
	18.	To ploughing the 4th time		4	
		To harrowing thrice		1	6
		To rolling			6
		To drilling the seed 1 inch by 12			6
		To harrowing ditto			6
		To seed for 1lb. of sugar loafes			6
July	20.	To harrowing 1st weeding			6
	28.	To breast hoeing 2d ditto		2	
Aug.	18.	To hand ditto 3d ditto		2	6
		To 1 year's rent, &c.		19	
			Expences	3	4
		<i>Contra</i>	<i>Cr.</i>		
Dec.	10.	By the value of the crop appraised		3	15 6
			Clear profit	11	6
			Expe.		

Experiments on Turnips.

The soil a light sandy loam worth about eighteen shillings per acre.

		<i>Broad-cast Acre.</i>	<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1789.						
Mar.	1.	To ploughing 1st time			5	
	31.	To break harrowing			1	
April	28.	To ploughing the 2d time			4	6
May	10.	To harrowing twice			1	
		To gathering the couch grafs			2	6
	24.	To 10 loads of dung (charged $\frac{1}{2}$)		12	6	
		To ploughing in ditto			4	
		To rolling				6
June	16.	To harrowing and rolling			1	
	18.	To ploughing 4th time			4	
		To 3 harrowings and 1 rolling			2	
		To feed for 1lb. of sugar loaf				6
		To sowing ditto				3
		To harrowing and rolling ditto			1	
July	20.	To harrowing for the first weeding				6
	28.	To hand hoeing 1st time			3	6
Aug.	18.	To ditto 2d time			2	6
		To 1 year's rent, &c.		19		
			Expences	3		3
		<i>Contra</i>	<i>Cr.</i>			
Dec.	12.	By the value of the crop appraised		3	3	
			Clear profit		2	9
		By gain in favour of the drilled crop			8	9
					11	6
						Expe-

Experiments on Barley.

After the Turnips.

<i>Drilled Acre.</i>		<i>Dr.</i>		
		<i>£.</i>	<i>s.</i>	<i>d.</i>
1789.	To half the charge of the dung	.....	12	6
Dec. 20.	To ploughing 1st time	.....	5	
1790.				
Mar. 24.	To break harrowing	.....	1	
April 10.	To ploughing 2d time	.....	4	
	To harrowing thrice	.....	1	6
	To rolling	.....		6
	To drilling the seed 2 inches by 9	.....		6
	To harrowing and rolling ditto	.....	1	
	To seed for 8 pecks at 10d.	.....	6	8
May 6.	To hoeing the 1st time	.....	2	
	To hand weeding the rows	.....	1	
June 16.	To hoeing 2d time	.....	1	6
	To hand weeding the rows	.....	1	
	To 1 year's rent, &c.	.....	19	
		Expences	2	17
		<i>Cr.</i>		2
Aug. 26.	By produce for 52 bushels 3s 6d	.....	9	1
		Clear profit	6	3
			10	

Expe-

Experiments on Barley.

After the Turnips.

<i>Broad-cast Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1789.	To half the charge of the dung	.....	12	
Nov. 20.	To ploughing 1st time	.....	4	6
1790.				
Mar. 24.	To break harrowing	.....	1	
April 10.	To ploughing 2d time	.....	4	
	To seed for 12 pecks at 10d.	.....	10	
	To sowing ditto	.....		6
	To harrowing ditto 4 times	.....	2	
	To rolling ditto	.....		6
May 20.	To weeding the 1st time	.....	3	
June 16.	To weeding ditto 2d time	.....	2	
	To 1 year's rent, &c.	.....	19	
		Expences	2	18 6
		<i>Cr.</i>		
	By produce for 47 bushels 3s 6d	.....	8	4 6
		Clear profit	5	6
Aug. 26.	By produce in favour of the drilled crop		17	10
			6	3 10

Experiments on Red Clover.

After the Barley.

<i>Drilled Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1791.	To seed for 1 stone in 1790		7	
Mar. 29.	To bush harrowing		1	
	To raking and gathering the weeds off		3	6
	To rolling			6
June 30.	To mowing 1st crop		2	6
	To making into hay		2	6
	To carting &c. the crop home	15		
	To mowing the 2d crop	2	6	
	To making ditto	3		
	To leading &c. ditto home	10		
	To 1 year's rent, &c.	19		
		Expences	3	6 0
<i>Contra</i>		<i>Cr.</i>		
	By the 1st eddish		4	
	By the 1st crop 2 tons at 3 pounds	6		
	By the 2d ditto—1½ ditto—ditto	4	10	
	By the 2d eddish		5	
			10	19 0
		Deduct expences	3	6 0
		Clear profit	7	13 0

Experi-

Experiments on Red Clover.

After the Barley.

<i>Broad-cast Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1791.	To 1 stone of seed in 1790		7	
Mar. 30.	To bush harrowing		1	
	To raking and gathering the weeds		3	
	To rolling			6
	To mowing the 1st crop		2	6
	To making it into hay		2	6
	To leading ditto home		12	
	To mowing the 2d crop — — —		2	
	To making ditto		2	6
	To leading ditto home — — —		9	
	To 1 year's rent, &c. — — —		19	
	Expences	3	1	0
<i>Contra</i>		<i>Cr.</i>		
	By the 1st and 2d eddishes — — —		8	
	By the 1st and 2d crop $3\frac{1}{4}$ tons — — —		9	15
		10	3	
	Deduct expences	3	1	
	Clear profit	7	2	
	By gain in favour of the drilled acre		0	11
		7	13	

Experiments on Wheat.

After the Red Clover.

		<i>Drilled Acre.</i>	<i>Dr.</i>		
			£.	s.	d.
1791.					
Oct.	4.	To ploughing the land		5	
		To 5 harrowings and 1 rolling		3	
		To drilling the seed 2 1/2 inches by 9			6
		To harrowing ditto			6
1792.		To seed for 8 pecks at 1s 6d.		12	
April	16.	To harrowing and rolling 1st weeding		1	
May	1.	To hoeing the 1st time		2	
	12.	To hand weeding the rows		1	6
	20.	To hoeing 2d time		1	6
	24.	To hand weeding the rows		1	
		To 1 year's rent, &c.		19	
			Expences		
				2	7 0
			<i>Contra</i>		
			<i>Cr.</i>		
Aug.	30.	By produce for 42 bushels at 5s	10	10	
		By sheep feeding April 15th		3	6
			Clear profit		
			8	6	6

Experi-

Experiments on Wheat.

After the Red Clover.

<i>Broad-cast Acre.</i>				<i>Dr.</i>		
				<i>£.</i>	<i>s.</i>	<i>d.</i>
1791.						
Oct. 4.	To ploughing	.....	.....		5	
	To feed for 9 pecks 1s 6d	.....	.....		13	6
	To sowing ditto	.....	.....			3
1792.	To harrowing 6 times	.....	.....		3	
April 16.	To ditto and rolling	.....	.....		1	
May 12.	To weeding the 1st time	.....	.....		3	
26.	To ditto the 2d ditto	.....	.....		2	
	To 1 year's rent, &c.	.....	.....		19	
				Expences	2	6 9
				<i>Cr.</i>		
	By sheep feeding April 15th	.....	.....		3	6
Aug. 30.	By produce for 36 bushels 5s	.....	.....		9	
				Clear profit	6	16 9
				By gain in favour of the drilled acre	1	9 9
					8	6 6

Experi-

Experiments on Potatoes.

The soil a light sandy loam, worth twenty shillings per acre.

		<i>Horfe-hoed Acre</i>	<i>Dr.</i>		
			£.	s.	d.
1789.					
Feb.	2.	To ploughing the 1st time		5	
	28.	To harrowing			6
		To 12 loads of dung 2s 6½d	15		
		To spreading ditto	1		
Mar.	1.	To ploughing the 2d time	4		
April	2.	To harrowing the 2d ditto			6
	24.	To ploughing with 3 ploughs	4		
		To planting with 12 hands 3 inches deep, 9 inches afunder, and 30 inch. alleys	4		
		To seed 30 bushels, cutting, &c. 1s 4d	2		
		To rolling			6
June	1.	To harrowing for 1st hoeing			6
	10.	To skim hoeing 1st time	1		
		To hand hoeing the rows	3		
	26.	To skim hoeing 2d time	1		
		To hand hoeing the rows	3		6
July	1.	To earthing up the rows	1		
	15.	To ditto	1		
Aug.	2.	To picking the weeds out	1		6
Oct.	20.	To taking up, pying, &c.	1	16	
			Expences	6	3 0
		<i>Contra</i>	<i>Cr.</i>		
		By produce for 500 bushels at 8d	16	13	4
			Clear profit	10	10 4
			Experi-		

Experiments on Potatoes.

		<i>Hand-hoed Acre</i>	<i>Dr.</i>	£.	s.	d.
1789.						
Jan.	12.	To ploughing 1st time			5	
Feb.	24.	To drag harrowing			1	
		To 12 loads of dung at 2s 6d, charged half		15		
		To spreading		1		
Mar.	1.	To ploughing the 2d time		4		
	30.	To harrowing twice		1		
April	24.	To ploughing with 3 ploughs		4		
		To planting with 12 hands, 3 inches deep, 8 inches asunder, and 24 inch. alleys		4	6	
		To feed for 36 bushels cutting 1s 4d	2	8		
June	1.	To harrowing for 1st hoeing			6	
	14.	To hand hoeing 1st time		5		
	26.	To ditto 2d time		4		
July	6.	To earthing up		15		
Aug.	3.	To picking the weeds out		1	6	
		To taking up, leading, pying, &c. —		1	14	
			Expences	7	3	6
		<i>Contra</i>	<i>Cr.</i>			
Oct.	24.	By produce for 420 bushels at 8d —		14		
			Clear profit	6	16	6
		By gain in favour of the horse-hoed acre		3	13	10
				10	10	4

Experi-

Experiments on Barley.

After the Potatoes.

		<i>Drilled Acre.</i>	<i>Dr.</i>		
			£.	s.	d.
1790.		To half the charge of the dung		15	
Jan. 18.		To ploughing 1st time		5	
Mar. 9.		To break harrowing		1	
April 10.		To ploughing 2d time		4	
		To three harrowings		1	6
		To rolling			6
		To drilling the seed 2 by 9 inches			6
		To harrowing and rolling ditto		1	
		To seed for 7 pecks at 11d.		6	5
May 14.		To hoeing the 1st time		2	
		To hand weeding the rows		1	
June 6.		To hoeing the 2d time		2	
		To hand weeding the rows			6
		To 1 year's rent, &c.		1	1
			Expences	3	1
			<i>Cr.</i>		
Sept. 4.		By produce for 56 bushels. 4s 6d		9	16 8
			Clear profit	6	15 3

Experi-

Experiments on Barley.

After the Potatoes.

<i>Broad-cast Acre</i>		<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1790.	To half the charge of the dung	.....		15	
Jan. 18.	To ploughing 1st time	.....		5	
Mar. 9.	To break harrowing	.....		1	
April 10.	To ploughing the 2d time	.....		4	
	To seed for 12 pecks at 10d	.....	10		
	To sowing ditto	.....			3
	To harrowing ditto 4 times	.....		2	
	To rolling	.....			6
May 14.	To weeding 1st time	.....		4	
June 4.	To ditto 2d time	.....		1	6
	To 1 year's rent	.....	1	1	
		Expences	3	4	3
		<i>Cr.</i>			
Sept. 6.	By produce for 49 bushels 3s 4d	.....	8	3	4
		Clear profit	4	19	1
		By gain in favour of the drilled acre	1	16	2
			6	15	3

Experiments on Red Clover.

After the Barley.

<i>Drilled Acre</i>		<i>Dr.</i>		
		£.	s.	d.
1791.	To feed, for 1 stone sown in 1790	7		
Mar. 30.	To bush harrowing	1	6	
	To raking and gathering the weeds	2	6	
	To rolling		6	
July 4.	To mowing 1st crop	2	6	
	To making	2	6	
	To carting home, &c.	12		
	To mowing 2d crop	2		
	To making ditto	2	6	
	To carting ditto home, &c.	9		
	To 1 year's rent, &c.	1	1	
		Expences		
		3	3	0
<i>Contra</i>		<i>Cr.</i>		
	By the first eddish		4	
	By produce 3 tons at 3l.	9		
	By the 2d eddish		6	
		9	10	0
		Deduct expences		
		3	3	0
		Clear profit		
		6	7	0

Expe-

Experiments on Red Clover.

After the Barley.

<i>Broad-cast Acre</i>		<i>Dr.</i>	<i>£.</i>	<i>s.</i>	<i>d.</i>
1791.	To 1 stone of seed in 1790 .....	.....		7	
Mar. 30.	To bush harrowing .....	.....		1	6
	To raking and gathering the weeds .....	.....		2	6
	To rolling .....	.....			6
June 20.	To mowing the 1st crop .....	.....		2	6
	To making it .....	.....		2	6
	To leading ditto home .....	.....		10	6
	To mowing the 2d crop .....	.....		2	
	To making ditto .....	.....		3	
	To leading ditto home .....	.....		7	6
	To 1 year's rent, &c. ....	.....	1	1	
		Expences	3	0	6
<i>Contra</i>		<i>Cr.</i>			
	By the first eddish .....	.....		4	
	By produce $2\frac{3}{4}$ tons at 3l. ....	.....	8	5	
	By the second eddish .....	.....		5	
			8	14	0
		Deduct expences	3	0	6
		Clear profit	5	13	6
By gain in favour of the drilled crop				13	6
			6	7	0

Experiments on Wheat.

After the Red Clover.

		<i>Drilled Acre</i>	<i>Dr.</i>		
			<i>£.</i>	<i>s.</i>	<i>d.</i>
1791.					
Oct.	1.	To ploughing the land		5	
		To 4 harrowings and 1 rolling		2	6
		To drilling the seed $2\frac{1}{2}$ by 9 inches			6
		To harrowing ditto			6
1792.		To seed for 8 pecks at 1s. 6d.		12	
April	17.	To harrowing and rolling 1st time		1	
	28.	To hoeing the 1st time		2	
May	2.	To hand weeding the rows		1	6
	16.	To hoeing the 2d time		1	6
	20.	To hand weeding the rows		1	
		To 1 year's rent, &c.	1	1	
			Expences 2 8 6		
			<i>Cr.</i>		
Sept.	14.	By produce for 36 bushels 6s.	10	16	
		By sheep feeding April 17th		3	
			Clear profit 8 11 6		

Expe...

Experiments on Wheat.

After the Red Clover.

<i>Broad-cast Acre</i>			<i>Dr.</i>		
			£.	s.	d.
1791.					
Oct. 4.	To ploughing the land.	—		5	
	To seed for 8 pecks 1s 6d	....		12	
	To sowing ditto —	....			6
1792.	To harrowing ditto 6 times	....		3	
April 19.	To ditto and rolling first time	....		1	
May 14.	To weeding the first time	....		3	
28.	To ditto second ditto	....		2	
	To 1 year's rent, &c. —	....	1	1	
			Expences		
				2	7 6
<i>Contra</i>			<i>Cr.</i>		
Sept. 18.	By produce for 30 bushels 6s	....		9	
	By sheep feeding April 20th	....			3
			Clear profit		
				6	15 6
				1	16
				8	11 6

In all those experiments the value of the straw is supposed equal to the expences of reaping, threshing, and carrying to market.

Experi-

Experiments on Cabbages.

The soil a hazel-coloured stiff loam, worth twenty shillings per acre.

<i>Horse-hoed Acre</i>			<i>Dr.</i>		
			£.	s.	d.
1790.					
Jan. 14	To ploughing	.....		5	
Feb. 20.	To harrowing twice	.....		1	
Mar. 11.	To 12 loads of dung at 3s	 half	18		
14.	To ploughing 2d time	.....		4	
April 20.	To drag harrowing	.....		1	6
	To harrowing	.....			6
	To gathering couch grafs	.....		1	6
May 14.	To ploughing into 4 foot lands	.....		4	
	To 5000 plants at 2s 6d per thousand	.....	12		6
	To planting ditto 48 inches by 30	.....		8	6
June 10.	To ploughing from the rows	.....		2	6
	To hand hoeing and hilling	.....		3	6
July 1.	To ploughing the land to the rows	.....		2	6
20.	To earthing up with horse hoe	.....		1	6
Aug. 1.	To hand weeding and killing vermin	.....		1	6
	To 1 year's rent, &c.	.....	1	1	
			<i>Expences</i>		
			4	9	0
			<i>Cr.</i>		
Dec. 21.	By value of the crop 50 tons at 4s per ton	.....	10	0	0
			<i>Clear profit</i>		
			5	11	0

Experi-

Experiments on Cabbages.

<i>Hand-hoed Acre.</i>				<i>Dr.</i>		
				£.	s.	d.
1790.						
Jan. 15.	To ploughing	.....	.....		5	
Feb. 21.	To harrowing twice	.....	.....		1	
Mar. 11.	To 12 loads of dung 3s	.....	half	18		
14.	To ploughing 2d time	.....	.....	4	6	
April 20.	To drag harrowing	.....	.....	2		
	To harrowing, &c.	.....	.....		6	
	To gathering couch grafs	.....	.....	1	6	
May 14.	To ploughing 3d time	.....	.....	4		
	To 5500 plants at 2s 6d per thousand			13	9	
	To planting ditto 36 inches by 30	.....	.....	10	6	
June 10.	To hand hoeing and earthing up	.....	.....	12		
July 20.	To ditto 2d time	.....	.....	7	6	
Aug. 1.	To hand weeding, &c.	.....	.....	2	6	
	To 1 year's rent, &c.	.....	.....	1	1	
				<i>Expences</i>		
				5	3	9
				<i>Cr.</i>		
Dec. 21.	By produce for 41 tons at 4s	—	—	8	4	0
				<i>Clear profit</i>		
				3	0	3
				2	10	9
				5	11	0

The

The foregoing experiments exhibit at one view my general practice in the drill system; and from them it is abundantly evident, that the drill-husbandry is superior to the broad-cast, and that the annual average profit arising therefrom amounts to more than the rent of the land.

In a variety of experiments conducted in the same manner, upon land worth about twelve or fourteen shillings per acre per annum, I never found the annual profits less than twelve or fourteen shillings per acre (upon an average) in favour of the drill-husbandry.

But although the advantages of the drill-husbandry are obvious, yet many farmers are enemies to it, and a much greater number are too indolent to go one step out of the old beaten path.

Proper instruments are wanting that would come cheap to the farmer, and have the requisites of strength and simplicity to recommend them.

In order to remove that difficulty, I have here endeavoured to establish and fix the principles upon which several drill machines may be constructed, which have every requisite to recommend them, and to render the drill-husbandry universal.

The construction of these machines shall be the subject of the following chapter.

C H A P. IV.

On the Construction of Drill Machines.

THIS chapter contains full directions for making two different kinds of drill machines, and a drill plough (which for cheapness, simplicity, strength and perfection, are superior to any now extant), for sowing or planting all kinds of grain, pulse, turnip, carrot, and rape seed, acorns, haws, holly berries, &c. on any kind of land, in any given quantity, and at any proper depth and distance required.

These machines are made upon such principles as will admit of various constructions, so as to accommodate the price to the circumstances of farmers of all ranks and degrees.

Words not being able to convey an adequate
idea

idea of those machines, I shall therefore give exact drawings of all their respective parts, and likewise explain and specify their different proportions in so plain and perfect a manner as will (I hope) enable every farmer to make his own at a reasonable expence, and agreeably to his own choice; and,

*1st. On the Construction of a Drill Machine
with Spherical Cups.*

This machine is made upon the principles of Don Joseph de Lucatello's Spanish Sembrador (see Mons. Duhamel's Husbandry, page 437); but so improved that it can sow eight rows at 8, seven at 9, six at 10, five at 12, four at 16 and 18, three at 20, 24, and 28, and two from 28 to 56 inches between the rows; and, with one man, a boy, and a horse, can drill an acre of land in one hour.

The expence of making this machine is as follows.

R 2

Iron

	£.	s.	d.
Iron work 5 stone at 6d per lb. -	1	15	0
2 large wheels 9s -	0	18	0
4 movement ditto 1s 6d -	0	6	0
96 feed cups 2d -	0	16	0
8 tin conductors 1s 3d -	0	10	0
Wood -	0	12	0
Workmanship -	1	9	0
	6	6	0

In March 1788, I presented this machine (which had then an apparatus for sowing pulverized manure), with two drill ploughs, to the Society instituted at London for the Encouragement of Arts, &c. in the Adelphi: they lay there several weeks before a committee could be formed to decide upon them, when it was determined that they had not merit enough to deserve the approbation of the Society.

As to the respectability of the Committee, I cannot say; but this I aver, that notwithstanding the judgment they passed, the Rev. James Cooke (who is a member of that Society, and perhaps was
one

one of the Committee) in his clerical liberality purloined the principal of those improvements, *in his new improved and simplified drill machine*, from mine, while they were in the Society's rooms. A comparative view of his drill machine with mine will not only prove this assertion, but also the superior principles upon which this machine is constructed.

PLATE

P L A T E I.

PLATE I.
FIG. 1. represents the left hand land wheel,
with two movement ones.

A. the land wheel thirty inches diameter, which turns on an iron arm, one inch and a quarter diameter, fixed on the end of a wooden axletree, in the same manner as those of coaches, &c.

The nave of this wheel is seven inches diameter at the thickest part, and eight inches long; the felloes are two by three inches square, and the spokes in proportion.

B. is one of the movement wheels, twelve inches diameter, has thirty-one teeth, and is fixed on the inner head of the nave by means of four grooves corresponding to its arms, as per figure.

C. is another movement wheel, ten inches diameter,

diameter, has twenty-six teeth, and is fixed ^{PLATE I.} upon the end of an iron axle five-eighths ^{FIG. 1.} of an inch square by a screw and nut. Upon this axle the feed wheels are put, and are carried round with it from the left hand to the right when the machine is in motion.

FIG. 2. represents the right hand land, ^{FIG. 2.} and two movement wheels.

D. is the land wheel, of the same dimensions as the other.

E. is one of the movement wheels, thirteen inches diameter, has thirty-three teeth, and is fixed upon the nave of the right hand land wheel, in the same manner as the other one.

F. is another movement wheel, nine inches diameter, has twenty-three teeth, and is fixed occasionally upon the end of the axle which carries the feed wheels. When oats are sown, these wheels are exchanged for the left hand

PLATE I. hand ones, in order that a larger quantity of
FIG. 2. feed may be sown per acre.

All those movement wheels are three quarters of an inch thick at the circumference, and one inch thick at the centre for three inches diameter, and are made of cast iron.

FIG. 3. FIG. 3. represents the left hand side of the frame of the machine, in which the circles A, B, and C shew how the land and movement wheels are connected, and the disposition of their centres.

D. is a profile of the side frame, forty-two inches long, and four by three inches square.

E. is a section of a wooden bar, five feet four inches long, and four by two inches square, for bracing the fore ends of the side frames together.

F. is a profile of the radius, which not
only

only supports the fore part of the machine, ^{PLATE}
 and regulates its horizontal position, but ^{I.}
 also in some degree regulates the quantity of ^{FIG. 3.}
 feed to be sown upon an acre, by raising or
 lowering the feed hoppers. It is about eigh-
 teen inches long, one inch and a half broad,
 and three eighths of an inch thick. This
 radius is fixed in the side frame by a bolt,
 which passes through it and the bar E, which
 are braced together, as per figure.

G. is a profile of an iron plate, with a
 square socket, and thumb screw, by which,
 and the holes in the radius F, the feed boxes
 are raised or depressed, for the purposes
 aforesaid, all of which are so plain, that any
 further description of them would be super-
 fluous.

H. is a section of the wooden axle-tree,
 exactly the length of the distance between
 the two side frames, viz. fifty-seven inches,
 and is four inches square. Upon the ends
 of this axle-tree are fixed two iron arms,
 S upon

PLATE upon which the land wheels move, and also
 I.
 FIG. 3. the whole machine, as upon a fulcrum, by
 means of iron staples which come under
 those arms, and which go through the side
 frames, to which they are fixed by nuts and
 screws at S. By this motion of the machine
 the coulters are taken out of the ground,
 while it is turning round at the land ends,
 or when it is travelling from one field to
 another, which shall hereafter be more fully
 explained.

I. is a section of the coulters bar five feet
 four inches long, and four by three inches
 and a half square. This bar is fixed to the
 side frames by two strong iron straps with
 nuts and screws, at T.

K. is a profile of a part of the left hand
 shaft of the machine, morticed into the
 axle-tree, where it is about three inches and a
 half square, and is in length about nine
 feet.

L. represents the left side handle of the machine, which is fixed to the side frames ^{PLATE I.} _{FIG. 3.} by two bolts and screws.

M. is a profile of the left hand side of the feed hopper and feed trough, and the right hand one is like it.

N. a cleat of wood screwed fast to the side of the feed trough, three inches and a half thick, four inches broad, and six inches long. This piece of wood is flush with the outside frames D, and in which the axle of the feed wheels moves.

O. the stop, which takes the wheel C out of gear with the wheel B, by pulling it backwards, by which means the sowing of the feed is stopped at pleasure. This stop is made of iron, and let into a mortice in the cleat N, and is prevented from going too far either forward or backward by the axle, and a pin screwed into it at i.

PLATE I.
FIG. 3. P P. are two pins fixed in the handle of the stop to keep it where it is placed by means of the prop Q, against which one of the pins butts. When the stop is pulled back to take the movement wheels out of gear, the fore pin comes behind the prop, which keeps it from going forward.

R. is a section of a scraper for keeping the wheels from clogging in moist weather.

U. is a small pulley for unlocking the machine, and for taking the coulters out of the ground when turning at the land ends, and which will be farther described hereafter.

V. is a socket two inches deep, in which the regulator moves.

FIG. 4. FIG. 4. is a profile of one of the inner partitions of the feed hopper, and feed trough, of which there are six, all of the same dimensions, which, with the middle and outside ones,

ones, serve to divide the feed hopper and feed trough into eight equal parts, for the reception of the feed, and feed wheels.

PLATE
I.
FIG. 4.

Those partitions are made of fir deal fourteen inches broad, and one inch thick, as represented by *a*, *b*, *c*, and *d*, shaped as per figure.

A. represents a section of the feed hopper.

B. is a section of the feed trough, in which there are seven partitions, besides the two outside ones, which divide it into eight equal parts.

The middle partition is like the two outside ones, and is not hollowed out so low as the others, because it serves as a rest for the axle of the feed wheels, as represented in the bottom part of the opening D.

C. is a socket in which the regulators move.

FIG. 5.

PLATE I.
FIG. 5. FIG. 5. is a profile of one of the partitions which divide the feed hoppers from the feed troughs. It is nine by six inches and a half square, and half an inch thick.

A. is let into the longitudinal partitions by grooves, and is hollowed out at bottom to the size of a semicircle of two inches radius.

B. goes across the upper ends of all the partitions of the feed hopper, which strengthens and ties them all together.

C. an aperture of two inches radius hollowed out to let the feed pass into the feed troughs; which is regulated by an iron plate that makes the aperture more or less, at pleasure.

PLATE

Fig. 1.

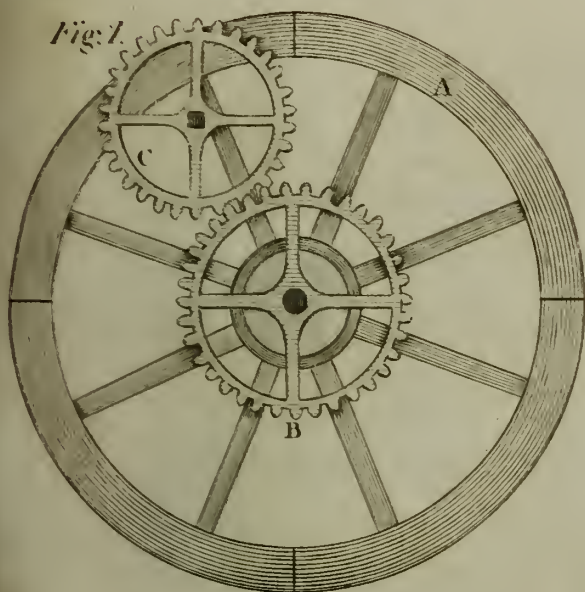


Fig. 2.

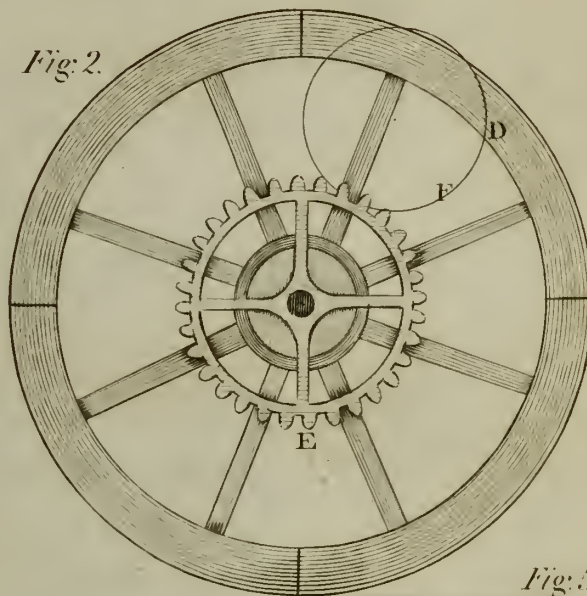


Fig. 5.

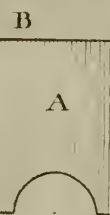


Fig. 4.

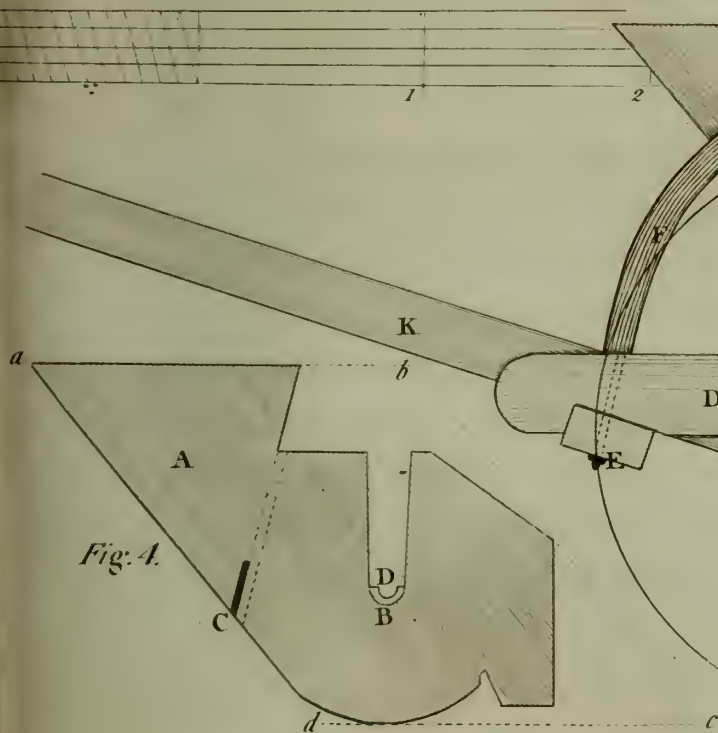
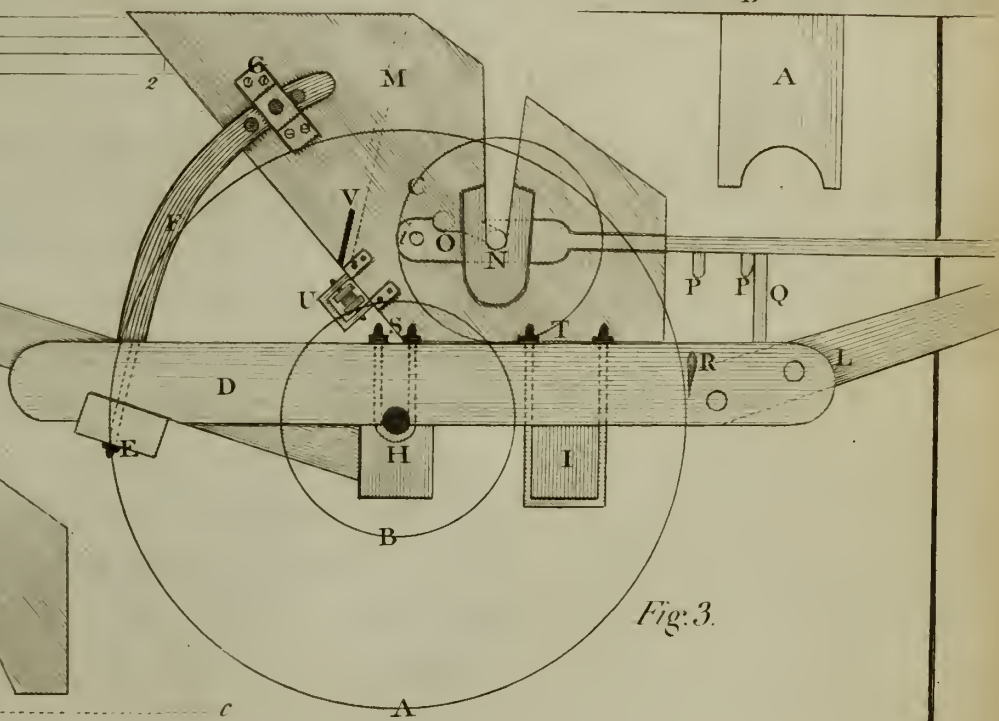


Fig. 3.



P L A T E II.

FIG. 1. is a profile of the whole machine ^{PLATE} ^{II.} with its appendages, as they appear against the ^{FIG. I.} inside of the right hand outer frame.

A. is a profile of one of the feed wheels with twelve cups. This wheel is six inches diameter, two inches thick, and hollowed out three quarters of an inch deep on each side, at one inch from the circumference, for the convenience of placing the feed cups, as per figure. Besides this, there are seven other wheels of the same dimensions, which are slipped on and taken off the axle at pleasure, are carried round with it from the right hand to the left within the feed troughs, and, as the cups move through the grain or feed, &c. they fill themselves therewith, carry it round till they are past the perpendicular, and then they drop it into the tin conductor I, which guides it between the wings of the coulter M, which makes a groove

PLATE ^{II.} groove or furrow in the foil for its reception,
FIG. 1. as per figure.

B. is a profile of the right hand side of the feed troughs.

C. is a section of the partition which divides the feed hoppers from the feed troughs.

D. is a section of the hind board of the feed trough, fifty-six inches long, half an inch thick, and eight inches broad.

E. is a section of the fore side and outer covering board of the feed hoppers, and of the fore and lower covering boards of the feed troughs; the circular part of which is covered with narrow laths, half an inch thick and fifty-six long, the straight part of which, and the feed hoppers, are covered with common boards, of the same length and thickness as the other.

F. the

F. the mouth of the feed hopper, fourteen inches wide inside measure.

PLATE
II.
FIG. I.

G. a section of the lid of the feed hopper, hinged to the partition C with leather, as per figure.

H. is a section of the lid of the feed trough, hinged to the partition C, and in the middle at *e*, with leather, as per figure.

I. is a side view of one of the tin conductors, of which there are eight in number. Part of the lower ends go between the wings of the coulter, and are stayed by the upper pieces N : those conductors are hung upon an iron rod half an inch diameter, of which *c* is a section, the ends of which are let into a notch made in each of the side frames.

K. is a profile of the shank of one of the coulters, of which there are eight, one inch by three eighths of an inch square.

T

L. is

PLATE
II.
FIG. I.

L. is a profile of the socket in which the coulters are fixed to the coulters bar by the nut and screw *n*, at any proper depth required. These sockets are inch and quarter by one and a half square outside measure, and that part which goes through the coulters bar is one inch by one and a quarter. The socket itself is of the same dimension with the shank of the coulters.

M. is a profile of the wings of the coulters, five inches deep by four broad. These wings are welded to the coulters, which is sharp edged before, and opens to the extent of one inch and a half behind, like a V, shaped as per figure, to prevent the weeds, &c. from obstructing the regular dropping of the feed.

N. is a part of the wings of the coulters divided from the other in order to be made circular behind, for receiving and staying the lower ends of the conductors.

O. is a section of the coulters bar, four inches

inches by three and a half square, and five feet four inches long.

PLATE
II.
FIG. I.

P. is a section of the wooden axle-tree, four inches square, and fifty-seven inches long.

Q. is a profile of a part of the right hand shaft of the machine.

R. is a section of the wooden bar, which braces the fore ends of the side frames together.

S. is a section of the tenons of the wooden bar which braces the shafts together. It is about forty-six inches long, and four by two inches square.

T. is a profile of the right hand side frame, of the same dimensions as the left hand one.

U. is a profile of the radius (of which d is the centre) which supports the fore part of

T 2

the

PLATE the feed hopper, and regulates its horizontal
II.
FIG. I. position.

V. is a section of another radius (which has the same centre) fixed in the middle of the bar R, for locking the machine to the shafts when drilling, and for taking the coulters out of the ground while it is turning round at the land ends, or when it is travelling from one field to another.

W. is a section of the regulator which regulates the quantity of seed to be sown. It consists of a plate of thin iron two inches broad, and fifty-six inches long, with two handles riveted to it, and which pass through screws fixed to the partition C.

This regulator goes across the bottom of the partition C (which divides the feed hopper from the feed troughs), and may be raised and lowered at pleasure by turning the handles right or left hand about ; which increases or diminishes the aperture of the partition C.

In this regulator there are nine notches one inch deep to receive the longitudinal parti-
tions, when it is raised upwards. PLATE
II.
FIG. I.

X. is a profile of the right side handle, which is fixed to the side frame T by two bolts and screws.

These handles are three feet long, and incline towards one another for the convenience of the person who guides the machine.

Y. represents the right hand land wheel.

Z. is one of the movement wheels, fixed upon the nave of the land wheel.

a. is a section of the spring bolt for locking and unlocking the machine.

b. is a section of an iron plate fixed to the under side of the feed troughs, the ends of which are rounded off, forming two pivots half

PLATE half an inch longer than the feed troughs.

II.
FIG. 1. These pivots rest in notches made in the side frames, and on which the feed hoppers and feed troughs move as on a fulcrum; by means of which, and the radius U, the feed hopper is raised or lowered, so as to render the distribution of the feed regular in going up or down steep hills.

c. is a section of the iron rod half an inch diameter, on which the conductors hang.

d. is a section of the iron arm fixed upon the axle-tree, and on which the land wheels move.

e. represents the hinges of the lid of the feed troughs, which is divided into two parts.

FIG. 2. FIG. 2. is a section of one of the feed wheels, as it is fixed on its axle for sowing wheat, barley, &c. the diameter of which is six inches: it is two inches thick, and hollowed out as per figure, for the convenience of fixing the feed cups.

FIG. 3.

FIG. 3. represents the circular surface of one of the feed wheels, in which the small dots represent the holes which receive the ends of the feed cups. PLATE
II.
FIG. 3.

FIG. 4. is a profile of one half of the coulters bar, in which the figures 8, 9, 10 and 12 express the different distances at which the coulters may be fixed, or the different distances between the rows, and also the number of rows that the machine can sow at those distances. FIG. 4.

Between A. and B. is twenty-eight inches and a half, and in the middle of the depth mortices are cut to receive the sockets, in which the coulters are fixed, as per figure.

C. is that part of the bar which is strapped to the side frame of the machine.

FIG. 5. *a a a a a a*. are sections of those parts of the feed trough partitions which immediately guide the grain, &c. into the conductors. Those parts of the partitions are made wider by FIG. 5.

PLATE II.
 FIG. 5. by cleats of wood to cover well the joints of the
 conductors, that no feed may be scattered
 between them.

1, 2, 3, 4 and 5 are profiles of the conductors, seven inches by five, square at the top; at five inches below they are contracted to two inches diameter, tapering downwards to one inch and a half; are fourteen inches long, and shaped as per figure. The four first represent one half of the conductors, of which Nos. 1 and 8, 2 and 7, 3 and 6, and 4 and 5 are alike on each side of the line *b*, which divides the machine into two equal parts.

FIG. 6. FIG. 6. represents a horizontal view of one half of the skeleton part of the machine, without the feed hopper and feed troughs, for the better understanding of all its parts.

A. the stop, between three and four feet long.

B. the scraper for cleaning the land wheels.

C. the

C. the prop which stays the stop.

PLATE
II.
FIG. 6.

D. a pulley for guiding the rope E. round the feed troughs.

E. a rope fixed to the spring bolt *a*, and fastened to the handle X. By pulling this rope the spring bolt *a* is drawn out of the notch of the radius V, which unlocks the machine; and, by lifting up the handles, the spring bolt goes into the upper notch, which takes, and keeps the coulters out of the ground when the machine is turning round, or when it is travelling from one field to another.

F. an iron brace for strengthening the shafts; it is made fast to the axletree and the shaft with iron bolts, as per figure.

L. one of the sockets in which the coulters are fixed, and *n* the nut and screw which fastens them to the coulters bar.

O. the coulters bar with notches to receive
U and

PLATE and stay the coulters. The under side of
^{II.}
 FIG. 6. those notches are covered with plate iron,
 with notches in it corresponding with those
 in the coulters bar.

P. the axletree on which the iron arm *d* is fixed by two bolts and screws, as per figure.

Q. the left hand shaft morticed into the axletree, to which it is fixed by a bolt passing through both, and also the iron arm.

R. the bar which braces the two side frames together.

S. the bar which braces the shafts together.

T. the left hand side frame of the machine.

U. the radius which supports the fore part of the feed hopper, and which regulates its horizontal position.

V. a section of another radius fixed in
 5. the

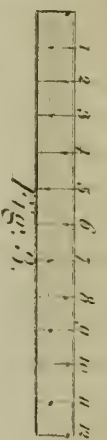


Fig. 2.

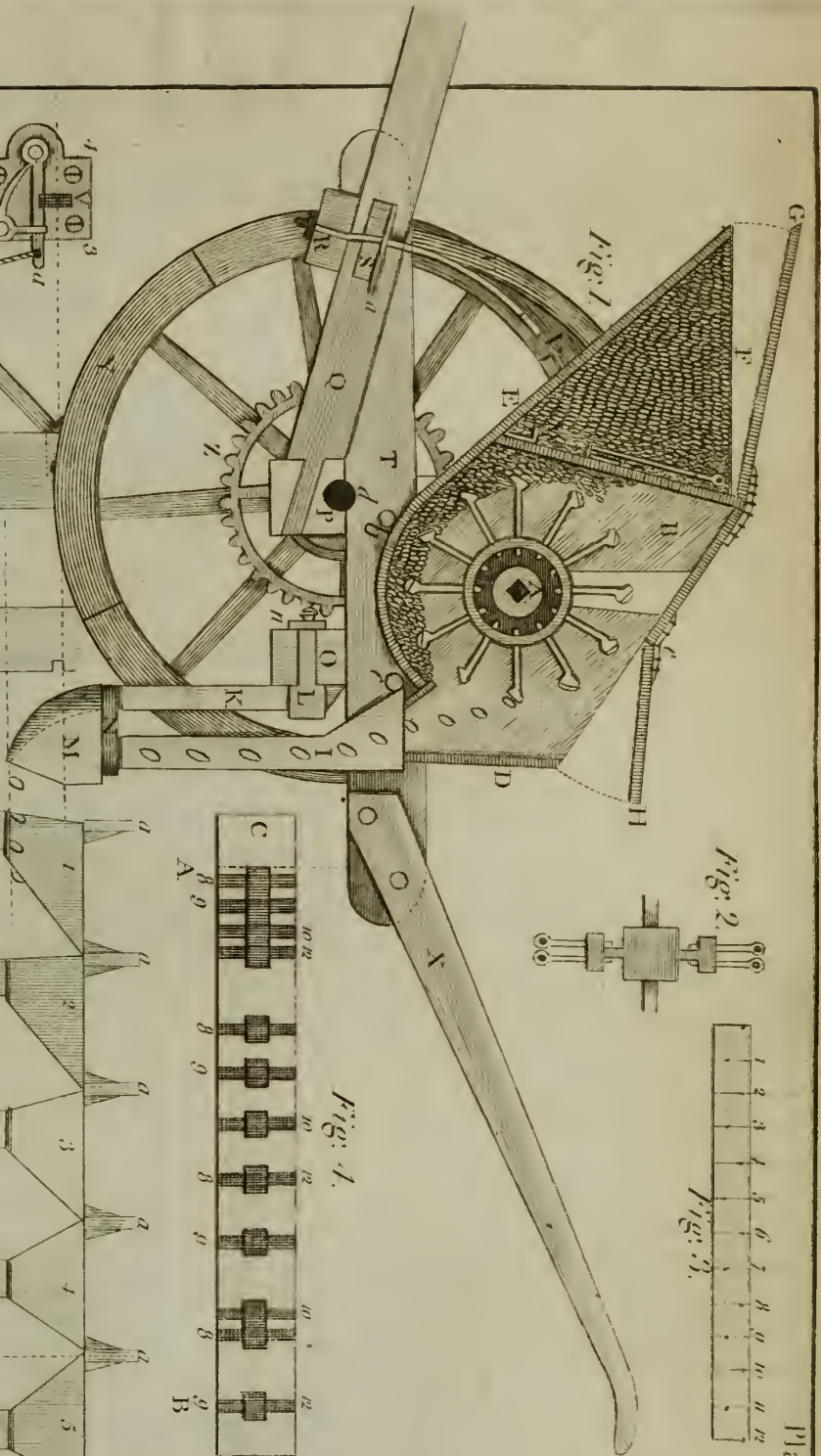
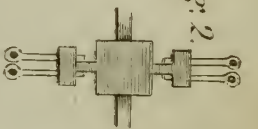


Fig. 1.

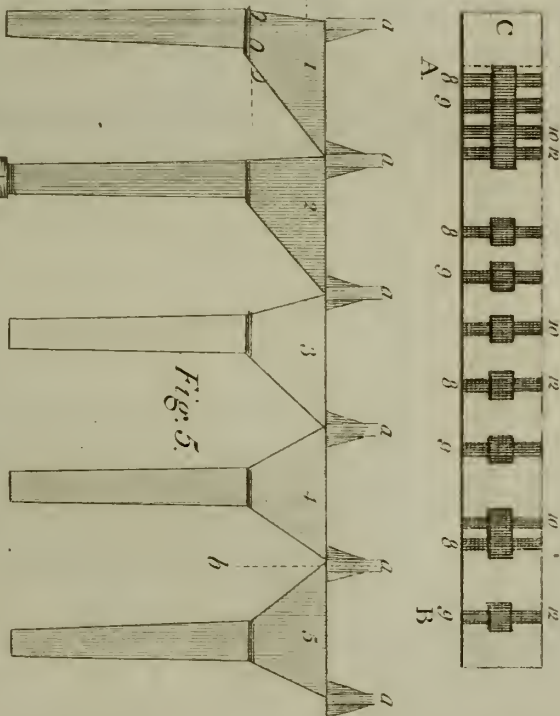


Fig. 5.

Fig. 6.

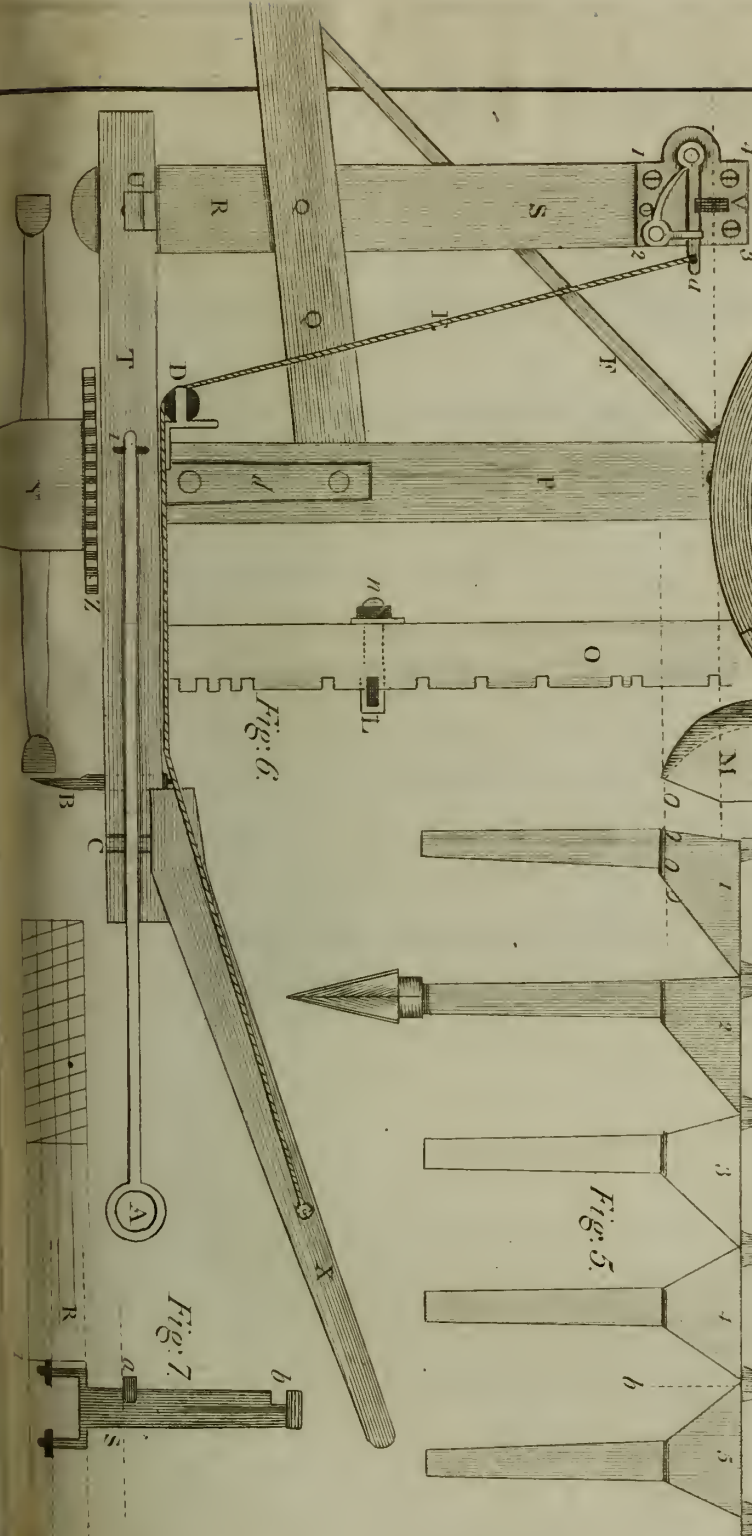
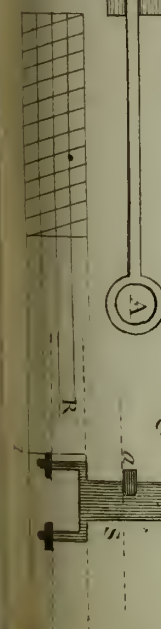


Fig. 7.



the bar R, and which passes through the bar PLATE S, on which the spring plate 1, 2, 3 and 4 II. FIG. 6. is fixed by screws, as per figure.

FIG. 7. is a profile of the middle radius, FIG. 7. which is fixed in the bar R, and which passes through the bar S, on which the spring plate is fixed.

a. is a section of the spring bolt, which, when pulled out of the notch of the radius, unlocks the machine; and, by lifting up the handles, the coulters are thereby taken out of the ground, and are kept out by the spring bolt going into the notch *b*: all of which are governed by the rope E. in Fig. 6.

P L A T E I I I .

PLATE
III.
FIG. 1.

FIG. 1. is a perspective view of the whole machine complete.

A A. the shafts.

B B. the land wheels.

C C. the movement wheels.

D D. the side frames.

E E. the handles.

F. the hind board.

G. the coulters bar.

H. end of the feed hoppers and feed troughs.

I I. &c. the coulters.

K. the scraper.

L. the rope which locks and unlocks the machine.

M. the stop.

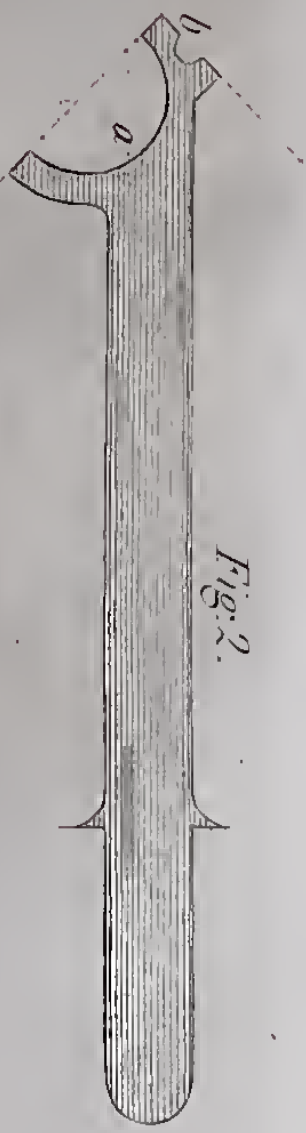
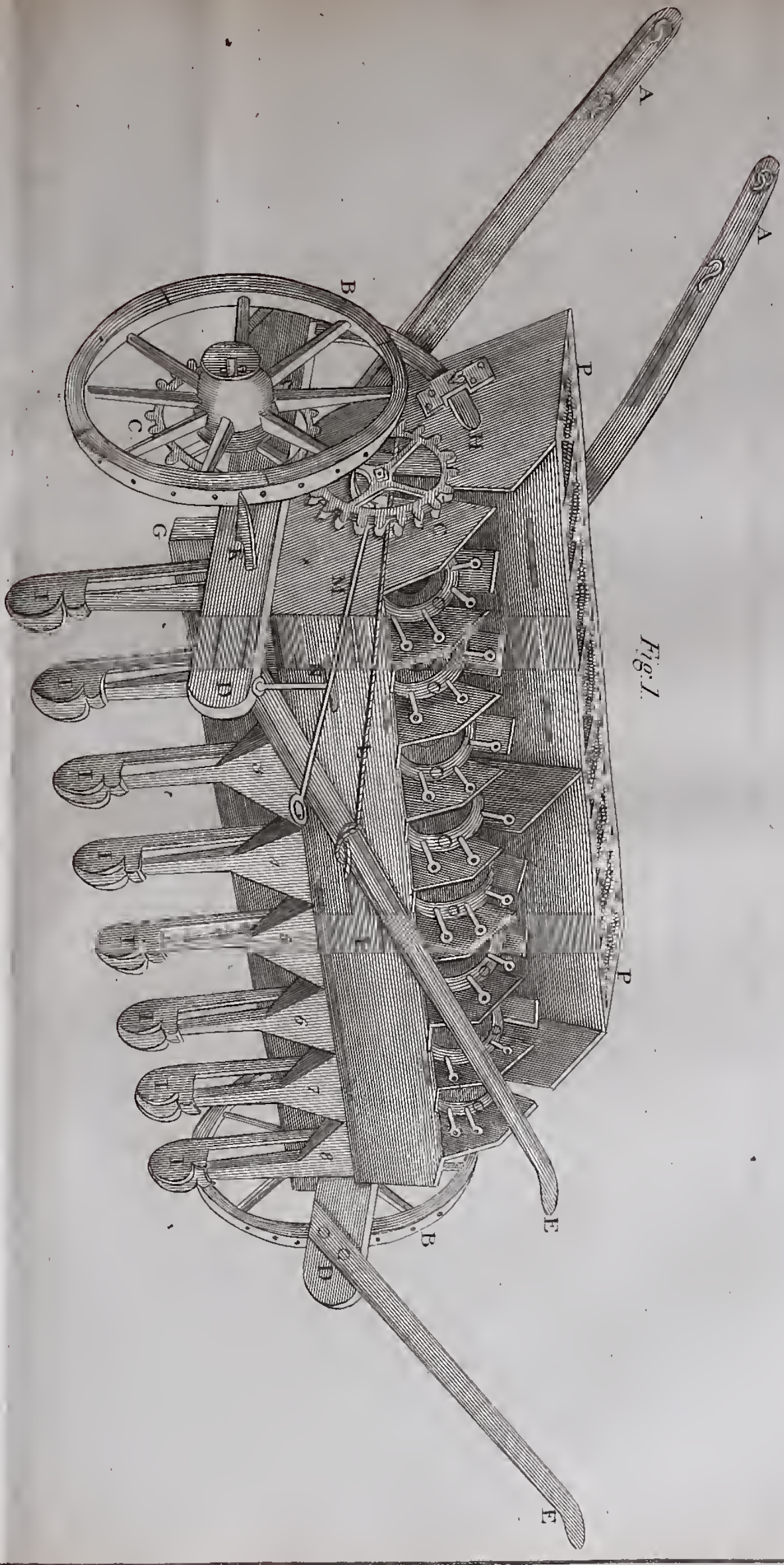
N. the prop.

O O. &c. the feed wheels which move in the feed troughs.

P P. the feed hoppers full of feed.

1, 2, 3, &c. the tin conductors.

FIG. 2.



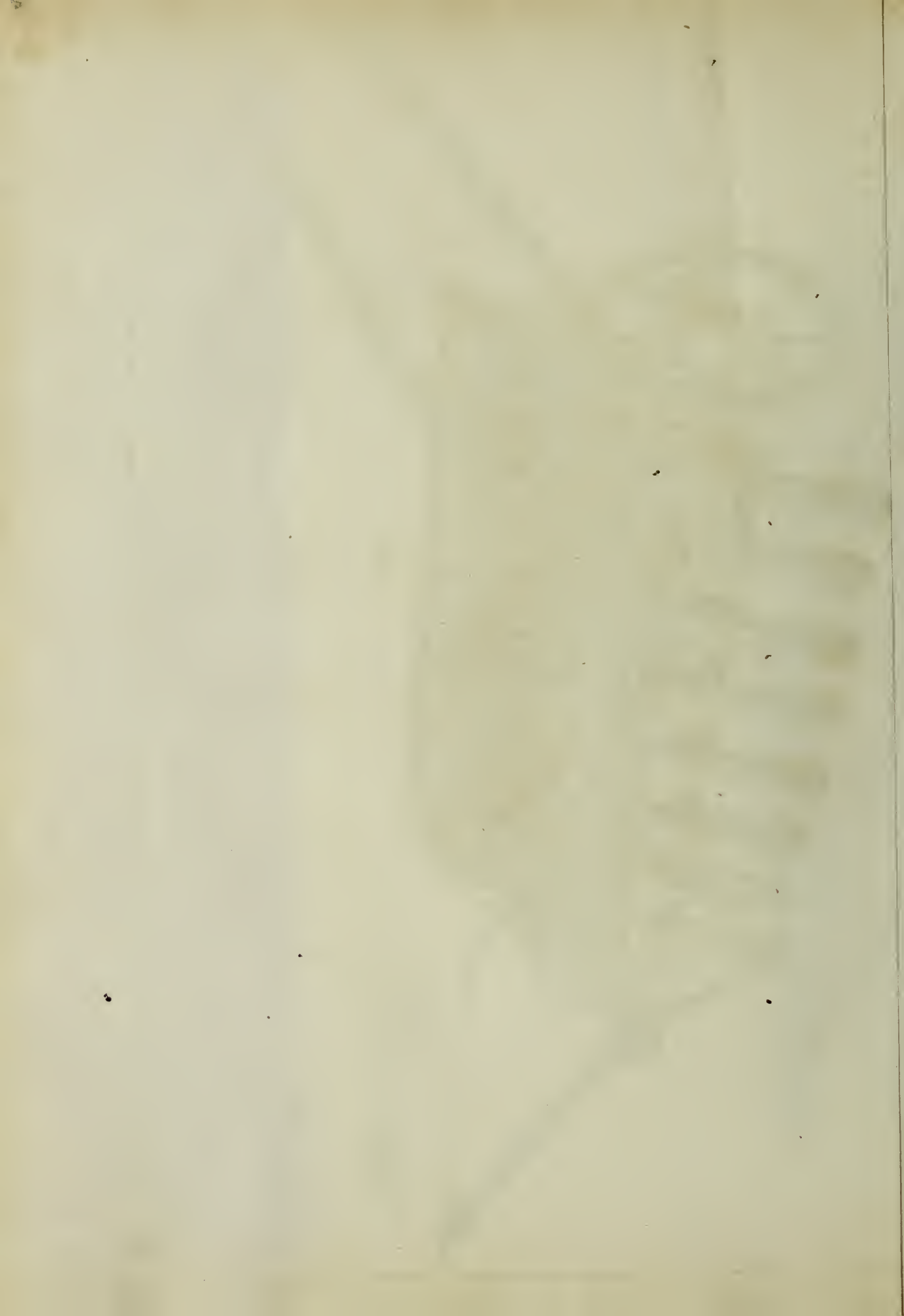


FIG. 2. is a geometrical construction of PLATE
III.
one of the feed cups. FIG. 2.

a. the cup for sowing large grain.

b. the cup for sowing small seeds.

*2d. On the Construction of a Drill Machine
with Indented Cylinders.*

This is perhaps the simplest and most useful drill machine that ever was or ever will be offered to the public. It is so simple in its construction, that any common carpenter or blacksmith may make and repair it. It is also so strong that it is not liable to be out of order ; and as there is but one movement to direct the whole, no skill is required to manage it.

As the frame or carcase of this drill machine is exactly similar to the one already described, it will therefore be unnecessary again to delineate those parts, or to repeat a description of them. And if the reader will cast his eye to FIG. 1, 2 and 3 of PLATE I. and to FIG. 4, 5, 6, and 7 of PLATE II. he will there see exact drawings of all those parts, with accurate descriptions annexed to their

their letters of reference: I shall therefore only give a general description of them, and then proceed to describe more particularly those parts in which they differ, viz. in the feed hopper and feed wheels.

P L A T E IV.

PLATE IV.
FIG. 1. represents the left hand side of the outer frame of the machine.

A. is one of the movement wheels, thirteen inches diameter, has thirty-three teeth, and is fixed upon the nave of the land wheel.

B. is the other movement wheel, nine inches diameter, has twenty-three teeth, and is fixed upon the end of an iron axle, five-eighths of an inch square, by a nut and screw. Upon this axle the feed wheels are put, and are carried round with it from the right hand to the left when the machine goes.

C. the left hand land wheel, thirty inches diameter.

D. is a profile of the left hand side frame of the machine.

E. a

E. a section of a wooden bar which braces the fore end of the side frames together.

PLATE
IV.
FIG. 1.

F. a section of the wooden axletree.

G. a section of the coultter bar.

H. a profile of a part of the left hand shaft of the machine.

I. a profile of a part of the left handle.

K. the prop on which the stop rests.

L. the standard of the left hand side of the machine morticed into the side frame D.

The lower part of this standard is four by three inches square, the middle part six by three to *a* and *b*, where there is a shoulder made of one inch broad for the ends of the hopper to rest on, and then it tapers from two to one inch thick on the upper edge. It is ten

X

inches

PLATE inches from *a* to *b*, fourteen from *c* to *d*, and
 IV.
 FIG. 1. ten inches and a half deep.

M. the stop which takes the movement wheels out of geer.

P P. are two pins to keep the stop where it is placed on the prop. At *r* is fixed a small pulley to guide the rope round the hopper.

FIG. 2. { FIG. 2. is a profile of the whole machine, with its appendages as they appear against the inside of the right hand outer frame.

A. is a section of the radius, which, by means of a spring bolt, locks and unlocks the machine.

B. a section of the wooden bar which braces the shafts together, with the spring bolt upon it.

C. represents the right hand land wheel.

D. is

D. is a profile of the right hand side frame. PLATE
IV.

FIG. 2.

E. is a section of the wooden bar which braces the fore end of the side frames together.

F. is a section of the wooden axletree.

G. is a section of the coultter bar.

H. is a profile of a part of the right side handle.

K. is a profile of the flank of one of the coultters.

M. is a profile of the wings of one of the coultters.

O. is a profile of the upper part of the wings, which are circular behind.

N. is a profile of one of the sockets in which the coultters move.

X 2

P. is

PLATE
IV.
FIG. 2.

P. is a side view of one of the tin conductors.

Having given a general description of the frame or carcase of this machine, I come now to describe more particularly those parts wherein this differs from the other.

I. is a profile of one of the partitions of the under boxes which convey the feed from the feed wheels into the tin conductors, of which there are nine.

The upper ends of those partitions next the feed wheels are six inches by one square ; the under ends next the tin conductors are three by two inches square, shaped as per figure.

Q. is a section of the fore board fifty-six inches long, and nine by one half square.

R. is a section of one of the indented cylinders or feed wheels, of which there are eight.

These

These cylinders are all of equal dimensions, viz. four inches long, and three inches diameter, with a hole in the centre five eighths of an inch square for the axle to pass through. All the cylinders are divided into four equal parts by three flight scratches. See letter R. FIG. 3. The middle scratch is divided into twelve equal parts, and in every one of those parts are hollowed out by a hot iron with a round knob twelve semicircular cavities of half an inch diameter for sowing large grain.

PLATE
IV.
FIG. 2.

In the middle of the right hand scratch are hollowed out fifteen semicircular cavities of three eighths of an inch diameter for sowing smaller grain.

In the middle of the left hand scratch are hollowed out eighteen semicircular cavities of one eighth of an inch diameter for sowing small seeds.

S. is a section of the hind board of the
lower

PLATE IV.
FIG. 2. lower feed boxes, which is divided into two halves; the under half is nailed fast to the partition I, and the upper half is fixed to the under one by hinges for the convenience of seeing how the feed drops.

TT. are slips of wood screwed on each side of the standards for confining the feed hopper in its proper place.

U. is a section of the lid of the feed hopper sixty-one inches long, and thirteen by one half inch square, hinged to the front side of the hopper as per figure.

1 1. are sections of the sides of the feed hopper twelve inches deep, and full half an inch thick.

V. the handle of the regulator; for an exact drawing, and a proper description of which, see FIG. 2. PLATE V.

ZZ. are sections of those parts of the bottom of the feed hopper, as they appear on each

each side of the aperture made in it for feeding the feed wheels.

PLATE
IV.
FIG. 2.

This view of the aperture measures two inches at bottom, three at the top, and is one inch and a half deep.

On the right hand side of this aperture is a groove of five eighths of an inch square for the reception of the regulating brush, as per figure.

This bottom piece is fifty-nine inches long, two inches and a half thick, eight inches wide at top, and five and a half at bottom.

In the middle of this piece is hollowed out a segment of a circle of three inches diameter, the chord of which is 2.9 inches, and verfed sine 1 inch. In this segment the feed wheels move, and deliver the feed as per figure.

FIG. 3. represents a hind view of one half of

PLATE
IV.
FIG. 3. of the machine, with its appendages, as they
would appear to the eye supposing the hind
board of the hopper to be glass.

A A. are sections of two lye stocks, which keep the axle with the feed wheels close to the bottom of the feed hopper, of which FIG. 4. is a profile. There is one at each end, and one in the middle.

B. is a profile of the bottom of the feed hopper, fifty-nine inches long, and one and a half thick, above the feed wheels. Two of those wheels appear as if the bottom of the feed hopper was cut down the middle, and two of them appear as they are seen when at work, in order to form a better idea of their position.

C C C C. are profiles of the female screws fixed to the hind side of the hopper, in which the male screws or handles of the regulators move, and set the brushes nearer or farther from the feed wheels, according to the
the

the quantity of seed required to be sown upon an acre, of which the two right-hand regulators exhibits a comprehensive view.

PLATE
IV.
FIG. 3.

D. is a section of the standard, which is morticed into the side frames, from which it is seven inches and one half to the bottom of the seed hopper, and from thence to the upper edge ten and one half. It is three inches thick to the bottom of the feed hopper, where there is a shoulder one inch deep for it to rest on, from thence it tapers to one inch thick at the upper edge.

E. is a section of the movement wheel, which goes upon the end of the axle of the feed wheels.

F. is a section of the stop, or the mortice in which it moves, and is two by one-half inch square, of which M. is a profile, FIG. 1.

IIII. are sections of the partitions that divide the under-boxes which convey the feed to the tin conductors.

Y

M. is

PLATE M. is a hind view of one of the wings of
 IV.
 Fig. 3. the coulter.

O. a hind view of the upper part of the wing, which is circular, in order to clasp the conductor.

PPPP. are hind views of the tin conductors; they are seven by five inches square at top, tapering to two inches diameter at five inches below it; from thence they taper to one inch and a half diameter, where they are received by the upper wings of the coulters, and are fourteen inches long.

QQQQ. a profile of the lower boxes.

RRRR. are profiles of four of the feed wheels, as they appear when at work. These wheels are placed for sowing large grain, by a pin passing through the axle at the right and left ends of each half of the feed wheels, as per figure. There are two more holes at the end of each half of the feed wheels, viz.

one inch right and left from the one at each end of the feed wheels.

PLATE
IV.
FIG. 3.

By shifting the feed wheels one inch to the right hand, and there pinning them fast, the smallest cavities are then brought under the middle of the brush for sowing small seeds.

By shifting the feed wheels one inch to the left hand, and there pinning them fast, the second sized cavities are then brought under the brush for sowing middling sized grain; all of which shiftings are easily performed.

rrr. are profiles of three small rollers for keeping the feed wheels at a proper distance from one another. These rollers are each three inches long, and one inch and a half diameter.

SS. is a profile of the hind side of the feed hopper.

VVVV. the handles of the regulators.

Y 2

The

PLATE IV.
FIG. 3. The brush of those regulators moves in the bottom of the feed hopper, and strickles the cavities of the feed wheels, and so regulates the quantity of seed to be sown, by screwing them nearer or farther off.

C C. represents sections of two of the apertures in the bottom of the feed hopper, which feed the feed wheels. This view of the apertures is three quarters of an inch wide at bottom, two inches at the top, and one inch and a half deep.

d d d d d. are sections of the partitions which divide the feed hopper into eight equal parts. If the boxes in the feed hopper are equally supplied with seed, the man who manages the machine may easily see when it is properly regulated: for if each feed wheel sows equal quantities of seed, those boxes will empty themselves equally also. When the seed is unequally sown by any of the feed wheels, the brushes must be regulated more accurately.

FIG. 4.

FIG. 4. is a profile of the tye stock, of ^{PLATE}
 which A in FIG. 3. is a section. ^{IV.}
 FIG. 4.

1 1 1. is a square flaple which goes through the bottom part of the feed hopper, to which it is fixed by nuts and screws.

2 2. are two pieces of brafs, in which the axle turns, and which keep the feed wheels close to the bottom of the feed hopper.

3. is a section of a part of the bottom of the feed hopper,

4 4. the nuts and screws which tye the whole to the bottom of the feed hopper.

FIG. 5. is a horizontal section of the tye ^{FIG. 5.}
 stocks.

1 1. are sections of that part of the staples which confines the brasses.

2. is

PLATE 2. is a section of the brasses themselves,
IV.
FIG. 5. with triangular grooves at each end to re-
ceive the staples, which are made triangular
on the inside to fit into those grooves.

PLATE

Fig. 5.



Fig. 1.

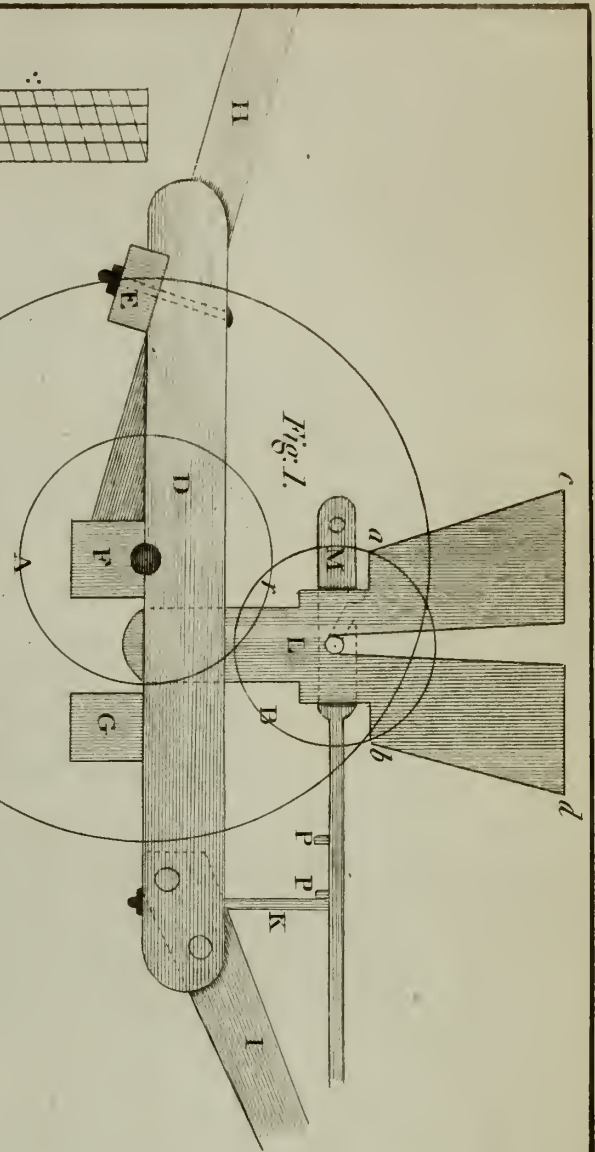


Fig. 3.

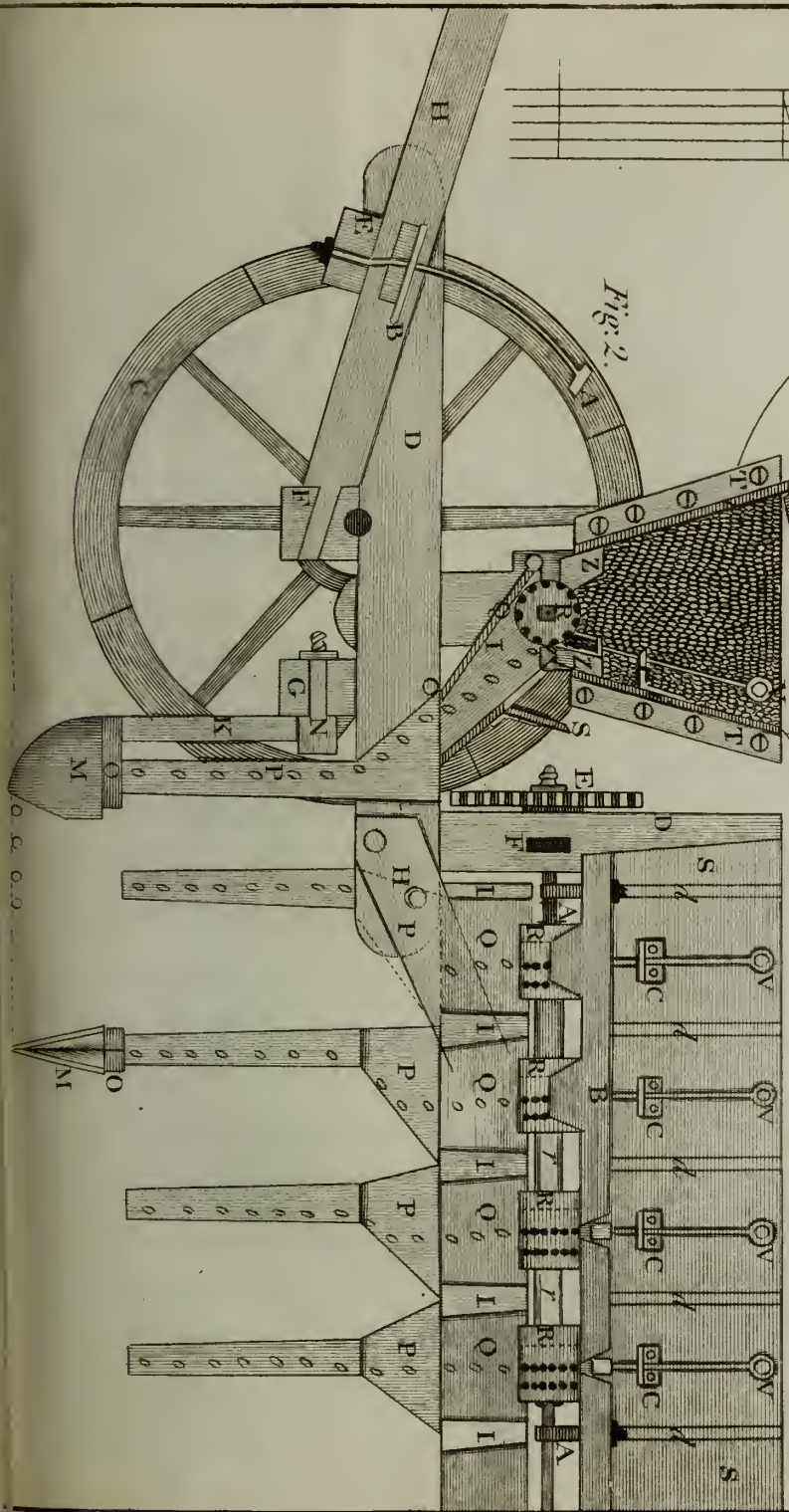
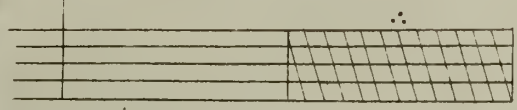


Fig. 2.



P L A T E V.

FIG. 1. is a geometrical construction of ^{PLATE}
one of the indented cylinders, or feed wheels, ^{V.}
in full size. FIG. 1.

A. the feed wheel, three inches diameter,
and four inches long.

B. a section of one half of the feed wheel.

C. a section of the axle hole, five-eighths
of an inch square.

D. the axle, five-eighths of an inch square,
and five feet four inches long within the nuts
and screws at each end.

E F. pins which keep the feed wheels in
their proper places. The large cavities are
now supposed to be under the brush; but if
the pin E be removed, and the feed wheel
moved to the pin F, the small cavities will
then.

PLATE then be brought under the brush; and if
 V.
 FIG. 1. the feed wheel is shifted one inch to the left
 hand, the cavities No. 3 will then be brought
 under the brush; which are all the shiftings
 necessary for sowing all kinds of grain, feeds,
 &c.

No. 1. are the cavities for sowing small
 feeds.

No. 2. are the cavities for sowing all kinds
 of large grain.

No. 3. are the middle-sized cavities for
 sowing middle-sized grain.

No. 4, 5, 6, 7, 8 and 9. are sections of
 the large cavities.

FIG. 2. FIG. 2. is a perspective view of the whole
 machine complete.

A A. the shafts.

B B. the land wheels.

C C. the movement wheels.

D D.

D D. the side frames.

E E. the handles.

PLATE
V.

FIG. 2.

F. one half of the hind board of the lower feed boxes turned down over the other, in order to show the feed wheels more completely.

G. the coulter bar.

H H. the standards.

I I. &c. the coulters.

K. the scraper.

L. the rope which unlocks and locks the machine.

M. the stop.

N. the prop.

O O. &c. partitions of the lower feed boxes.

P. the feed hopper.

Q. the lid of the feed hopper.

r. a button which fastens the moving part of the fore board of the lower feed boxes when they are shut up from the weather.

The feed wheels appear under the feed
Z hopper,

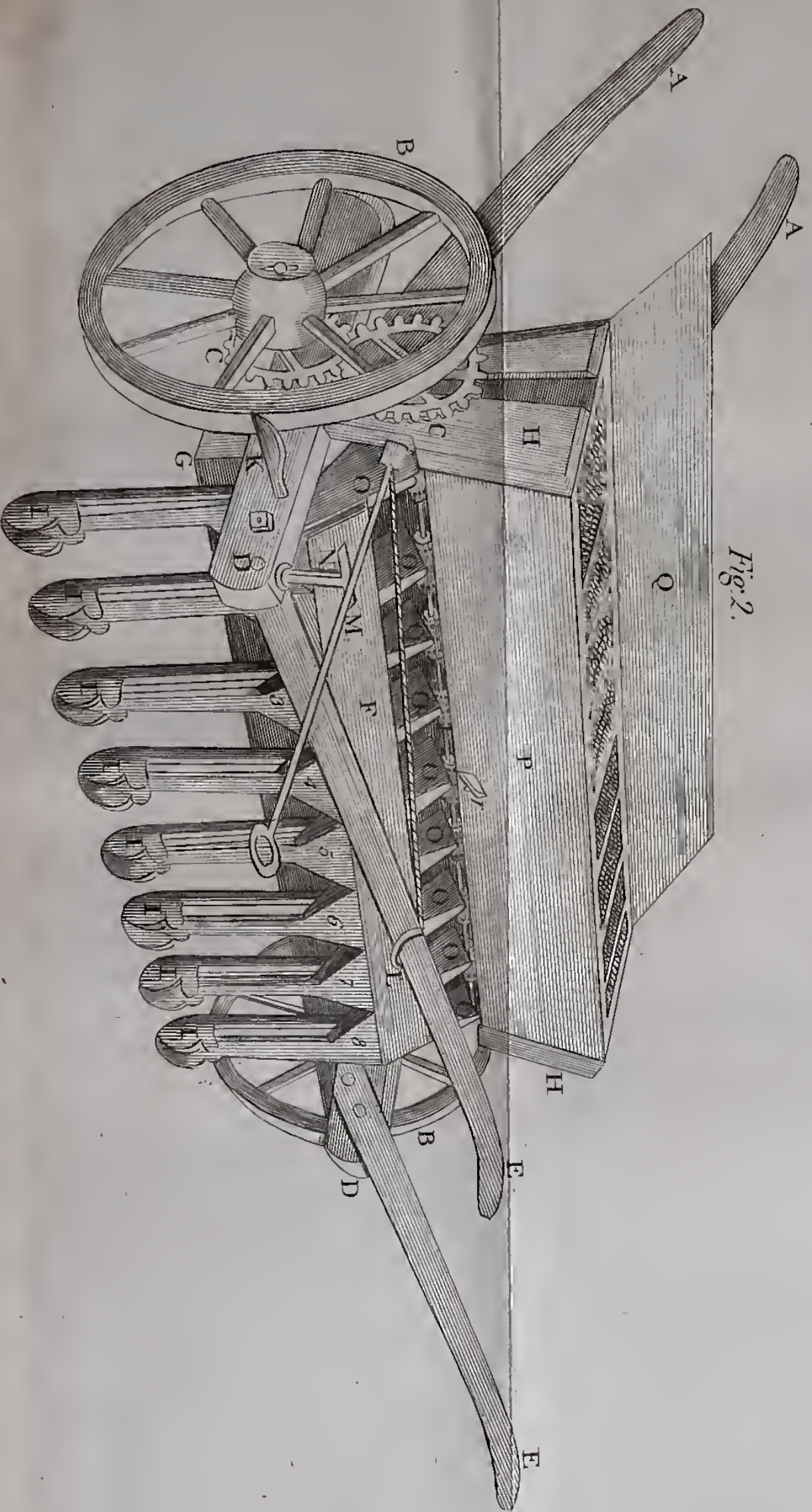
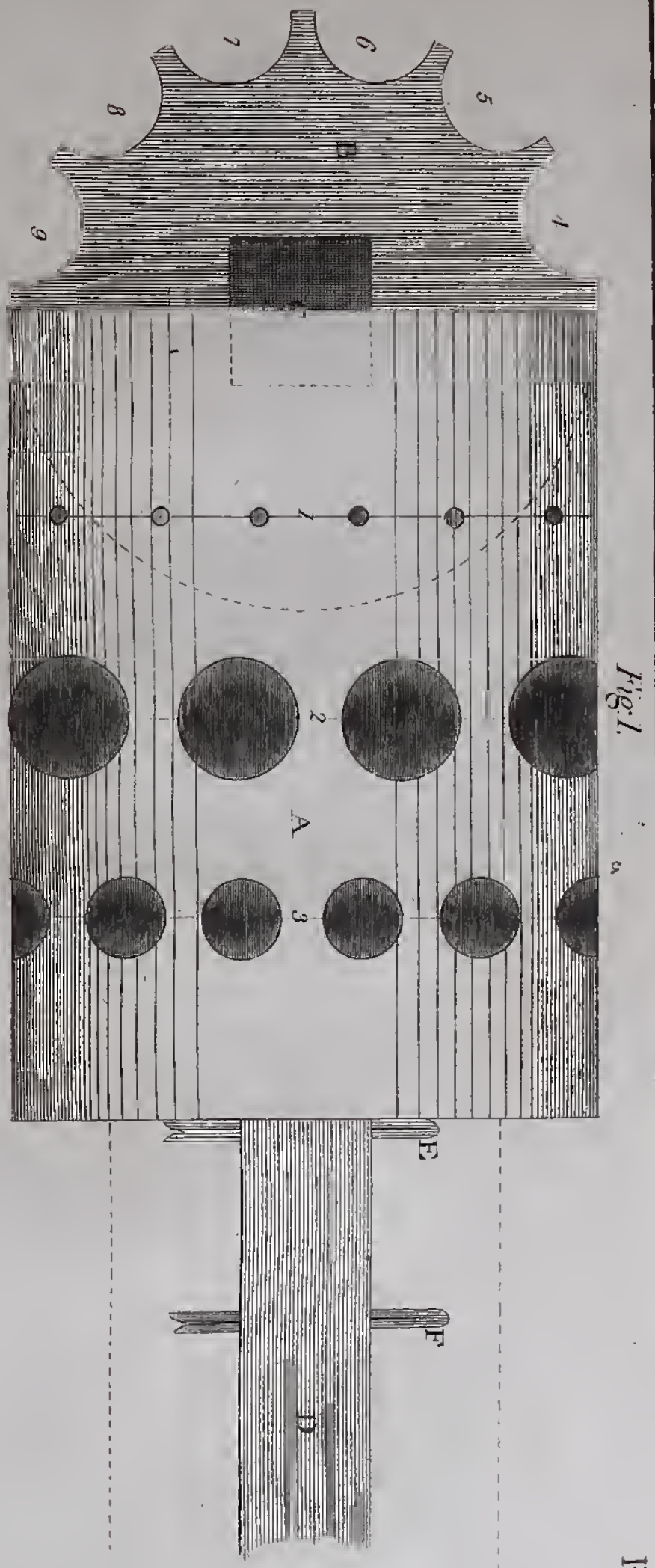
PLATE ^{V.}hopper, without any letter of reference,
 FIG. 2. left it should obscure them.

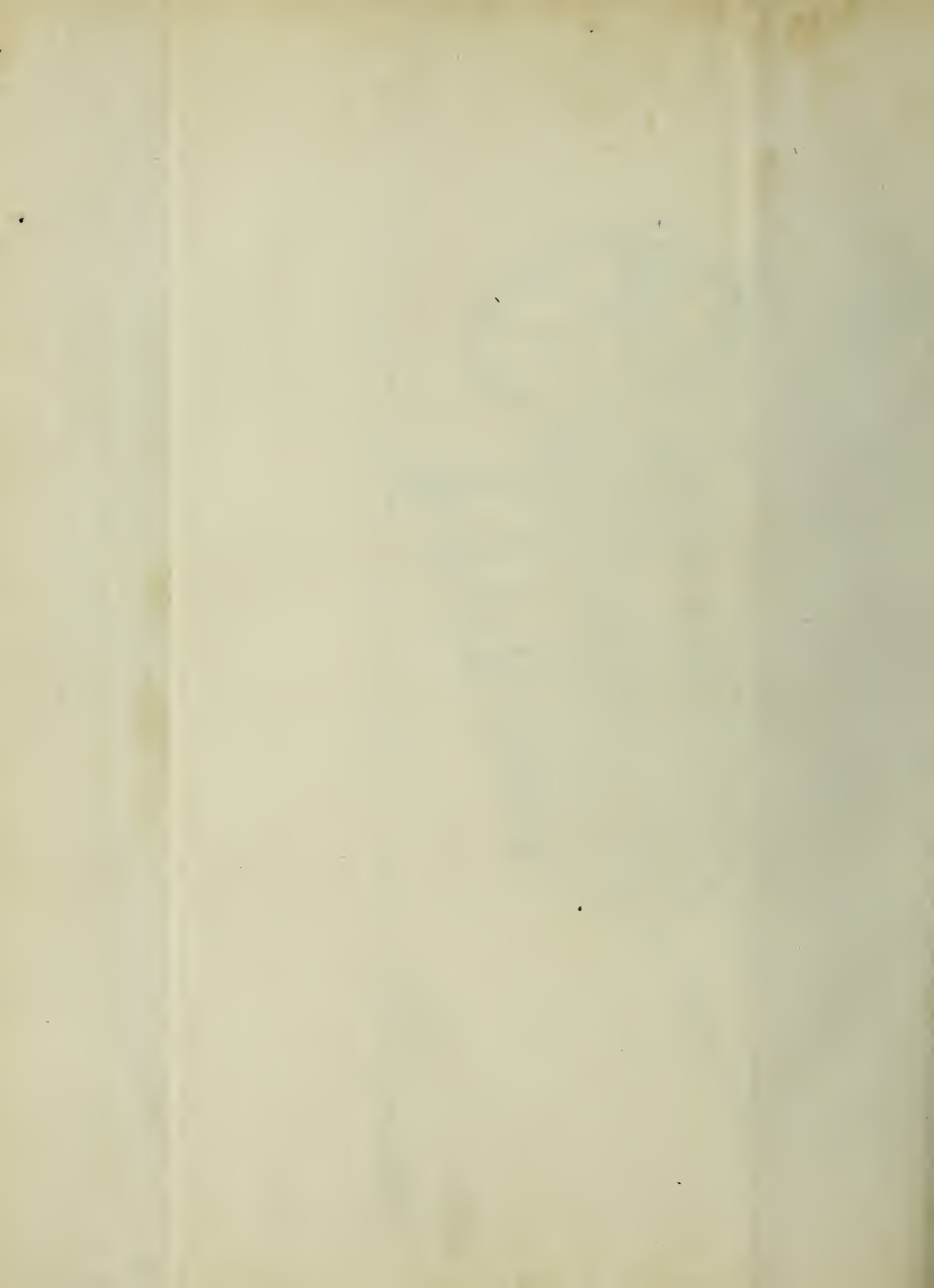
1; 2, 3, 4, 5, 6, 7 and 8, the tin conductors.

The expence of making this machine is as under.

	£.	s.	d.
Ash wood	-	0	6 6
Fir wood	-	0	5 6
Two land wheels	-	0	16 0
Two movement ditto	-	0	3 0
Eight regulators	-	0	10 0
Eight feed wheels	-	0	4 0
Six division ditto	-	0	0 6
Eight tin conductors	-	0	10 6
Three tye stocks	-	0	4 6
Six stone of iron at 6s	-	1	16 0
Workmanship	-	2	0 0
		6	16 6

PLATE





P L A T E VI.

3d. *On the Construction of a Drill Plough
with Indented Cylinders.*

THIS is perhaps the simplest, cheapest, and ^{PLATE VI.} most useful drill plough that ever was, or ever will be offered to the public. It is made to be fixed to the side of any common plough beam, and is used and taken off at pleasure. It can sow all kinds of grain, pulse, seeds, &c. on any kind of land, in any given quantity, and at any proper depth and distance required; and the drill apparatus may be made complete for one guinea and a half.

FIG. 1. is a profile of the frame, coulter, ^{FIG. 1.} tin conductor, mould board, and a section of the seed wheel, and hopper.

Z 2

A. is

PLATE VI.
FIG. 1. A. is a section of the feed wheel three inches diameter, and four inches long. In this wheel are three rows of different sized cavities, as described in FIG. 1. PLATE V. A bare inspection of the figure shows at one view how the feed is delivered.

B B. a profile of the frame in which the feed wheel moves. This frame is three feet three inches long and three inches thick. In this frame is hollowed out a semicircle three inches diameter in which the feed wheel moves as per figure. Above the feed wheel is formed an aperture for feeding the feed wheel with feed. This view of the aperture is two inches wide at bottom, and three at top.

C. is a piece of wood nailed on the outside of the frame, in which the axles of the movement wheels turn, and which guides the feed into the tin conductor. This piece of wood is one inch thick, and shaped as per figure.

D. the

D. the feed hopper five inches wide at bottom, thirteen at top, and eight inches deep; which exhibits at one view how the feed wheel is fed with feed, and how the feed is delivered into the tin conductor, &c.

PLATE
VI.
FIG. I.

E. the regulator which governs the quantity of feed to be sown upon an acre.

F. the tin conductor, which conveys the feed into the coulter.

G. is a profile of the mould board in which the coulter is fixed, as per figure, and which may be shifted right or left as occasion may require.

H. the lid of the hopper hinged as per figure.

I. the axle hole of the land wheel, three quarters of an inch diameter.

K. the coulter fixed in the mould board by a wedge, the fore edge of which must be
7 parallel

PLATE parallel with the land side of the plough.
 VI.
 FIG. 1. The aperture in the mould board is wide at the underside in order that the coulter may be shifted right or left as occasion requires.

FIG. 2. FIG. 2. is a perspective view of the coulter, with the iron plate which is nailed to the upper edge of the mould board, and in which the flank of the coulter is fixed.

FIG. 3. FIG. 3. is a horizontal view of the plough and drill apparatus.

A. the land wheel, twenty-eight inches diameter, and made of iron.

B. the iron rod which governs the land wheel.

C. the handle which raises the end of the iron rod, and land wheel, off the ground, which stops the seed from falling.

D. the frame to which the drill apparatus is

is fixed; it is three by two inches square at each end, and six by three in the middle for one foot long.

PLATE
VI.
FIG. 3.

E. the standard which supports the fore end of the frame, which goes into a square eye four by two inches, and is wedged fast.

F. an iron bolt which fixes the hind end of the frame to the handle of the plough, as per figure.

G. the axle on which the land wheel is fixed, and is two feet long. To the end of this axle is joined another, by means of two eyes, which goes through the frame, and on which the large movement wheel H is fixed.

H. a movement wheel, eight inches diameter, fixed on the jointed end of the axle G.

K. another movement wheel, four inches diameter, fixed on the axle of the feed wheel,
which

PLATE VI. which goes twice round for once of the land
 FIG. 3. wheel.

L. the aperture between the hopper and feed wheel. This aperture is three by two inches square on the upper side, and two by three quarters of an inch on the under side next the feed wheel.

On the right hand side of this aperture, next L, is a groove five-eighths of an inch square, for the regulator to move in.

o o o o. are the two side pieces, one foot long and one inch thick.

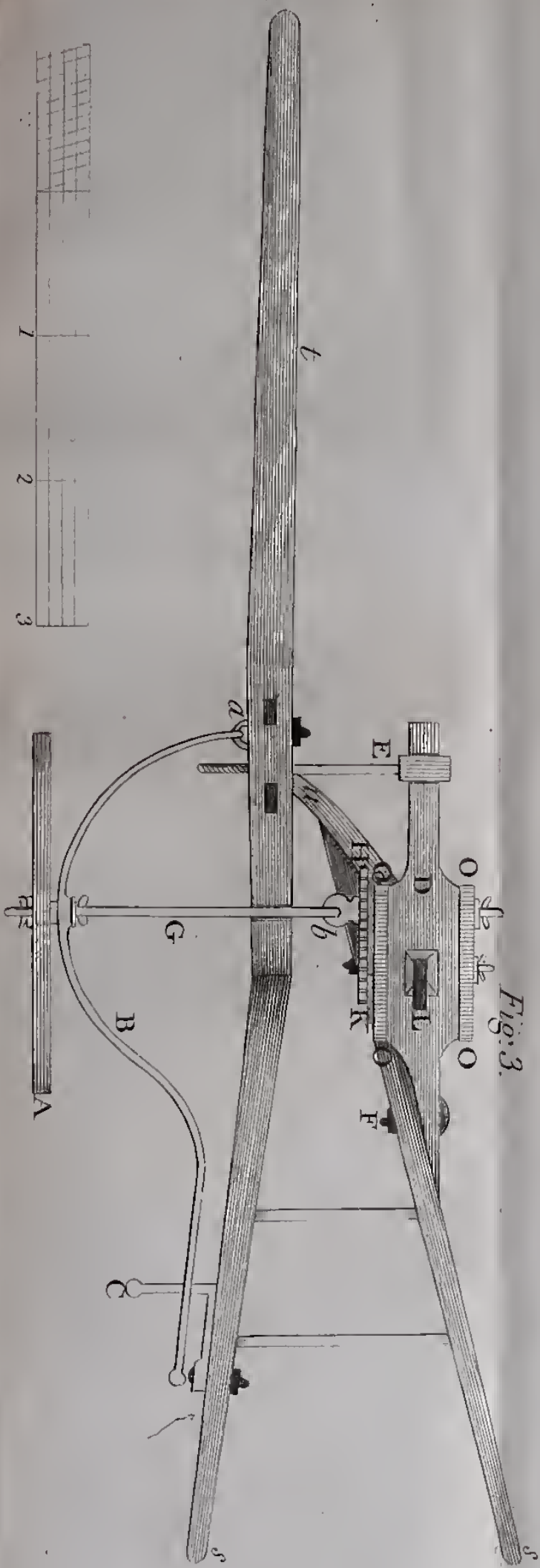
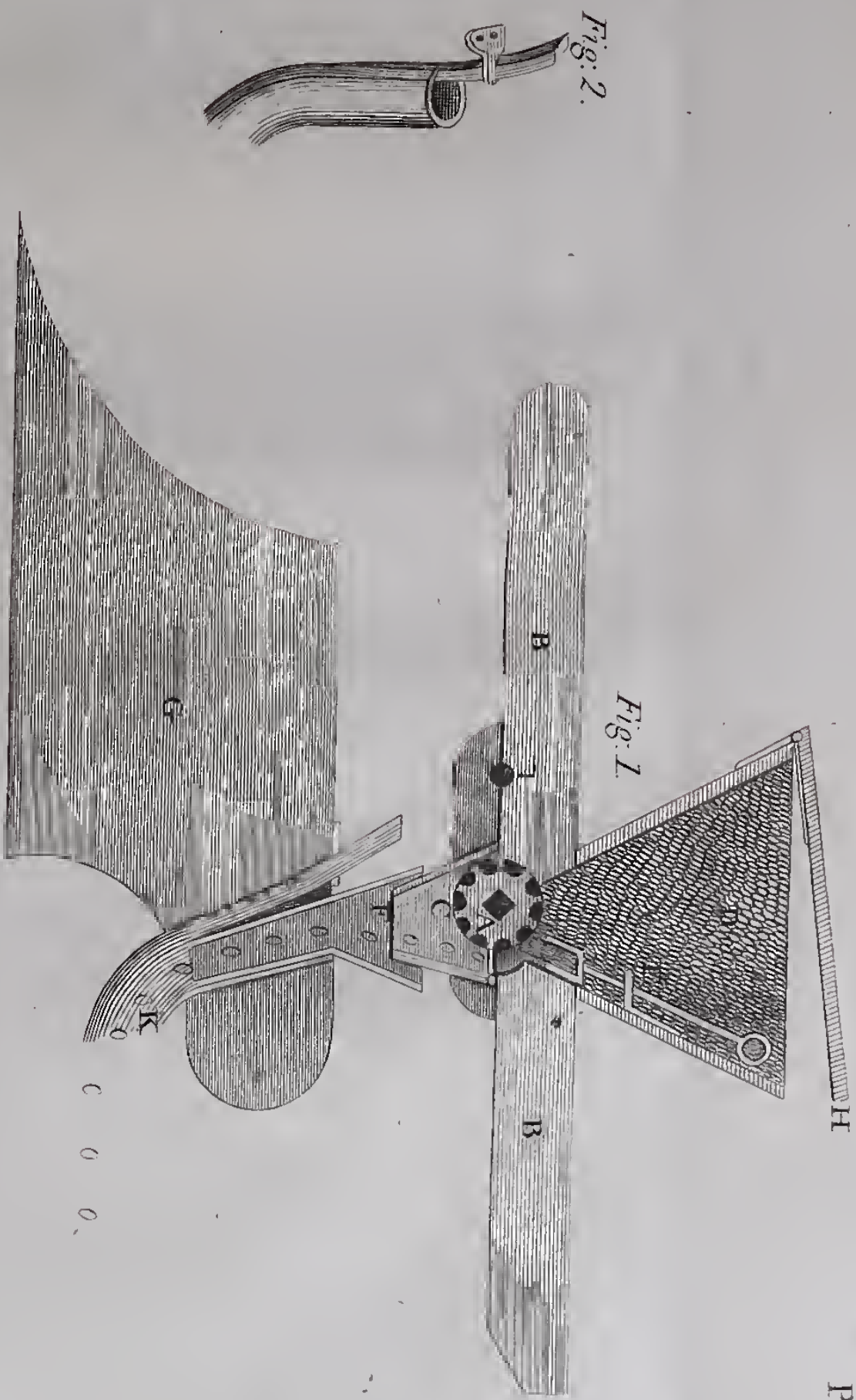
a b. are the joints of the iron rod B and the axle G. all of which have been laid down from the annexed scales.

s s. the handles of the plough.

t. the beam.

u H o. the mould board.

PLATE



P L A T E VII.

FIG. 1. is a perspective view of the plough PLATE VII.
equipped, with its drill apparatus complete. FIG. I.

A. the land wheel.

B. the iron rod which governs the land wheel.

C. the handle which lifts up the iron rod and stops the sowing.

D. the frame of the drill apparatus.

E. the seed hopper.

F. the large movement wheel.

G. the axle of the land wheel, on which the large movement wheel is fixed.

A a

H. the

PLATE H. the small movement wheel, on the
VII.
FIG. 1. axle of which the feed wheel is fixed.

K. the standard which supports the fore-
end of the frame.

The tin conductor, flank of the coulter, and the iron plate in which it is fixed, cannot be seen in this view; but are represented by themselves in FIG. 4. All of which give so clear an idea of the construction of this plough, and its drill apparatus, that any farther description of it seems unnecessary.

FIG. 2. FIG. 2. is a section of the regulator in full size.

A. a section of the front plate one inch by two square, the ends of which move in grooves in the sides of the aperture between the hopper and feed wheel.

B. the socket, five-eighths of an inch square outside measure, riveted to the middle of the
front

front plate. This socket is made a little warm, and filled one quarter of an inch deep with a mixture of pitch, rosin, and bees wax melted together; then a bunch of strong bristles is squeezed into it, and wedged tight behind. Cut the bristles straight over by a hot iron, which will form a very strong brush as at *a*, by which the seed is regularly delivered without the least injury.

PLATE
VII.
FIG. 2.

C. a part of the front plate doubled over the top of the socket, to which the screw is loosely riveted.

D. the screw plate fixed to the end of the hopper, in which the screw works.

E. a section of the end of the hopper, to which the screw plate is fixed.

F. the screw which raises or lowers the socket and brush, and thereby regulates the quantity of seed to be sown: when the brush touches the cavities of the feed wheel, a small

A a 2

quantity

PLATE VII.
FIG. 2. quantity of seed is delivered; but when the brush is raised as per figure, a much larger quantity of seed is discharged. The least attention will soon teach any person to know how to set the regulator, so as to sow any definite quantity of seed upon an acre.

G. a section of part of the feed wheel.

H. a part of the frame of the drill apparatus.

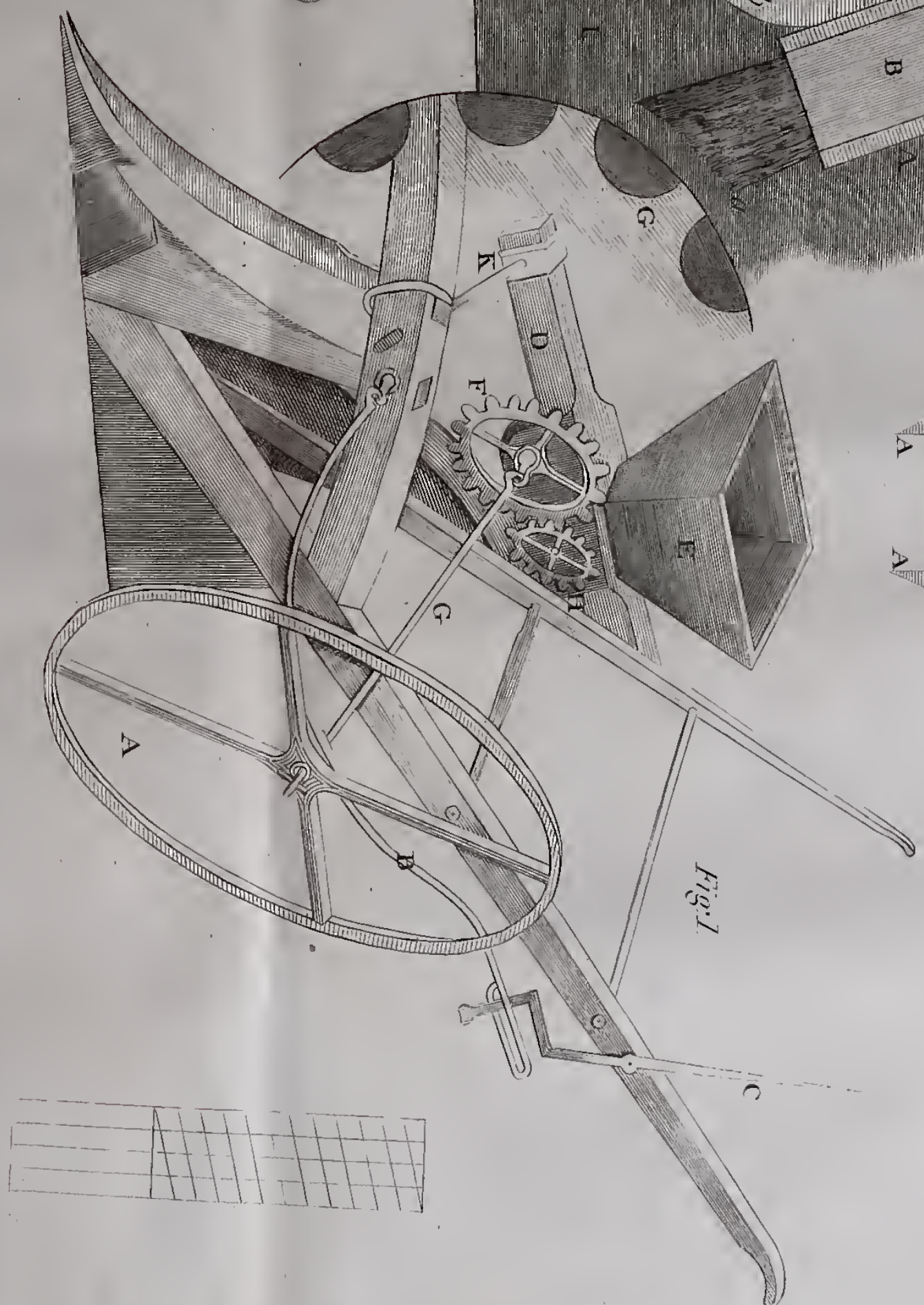
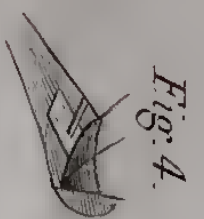
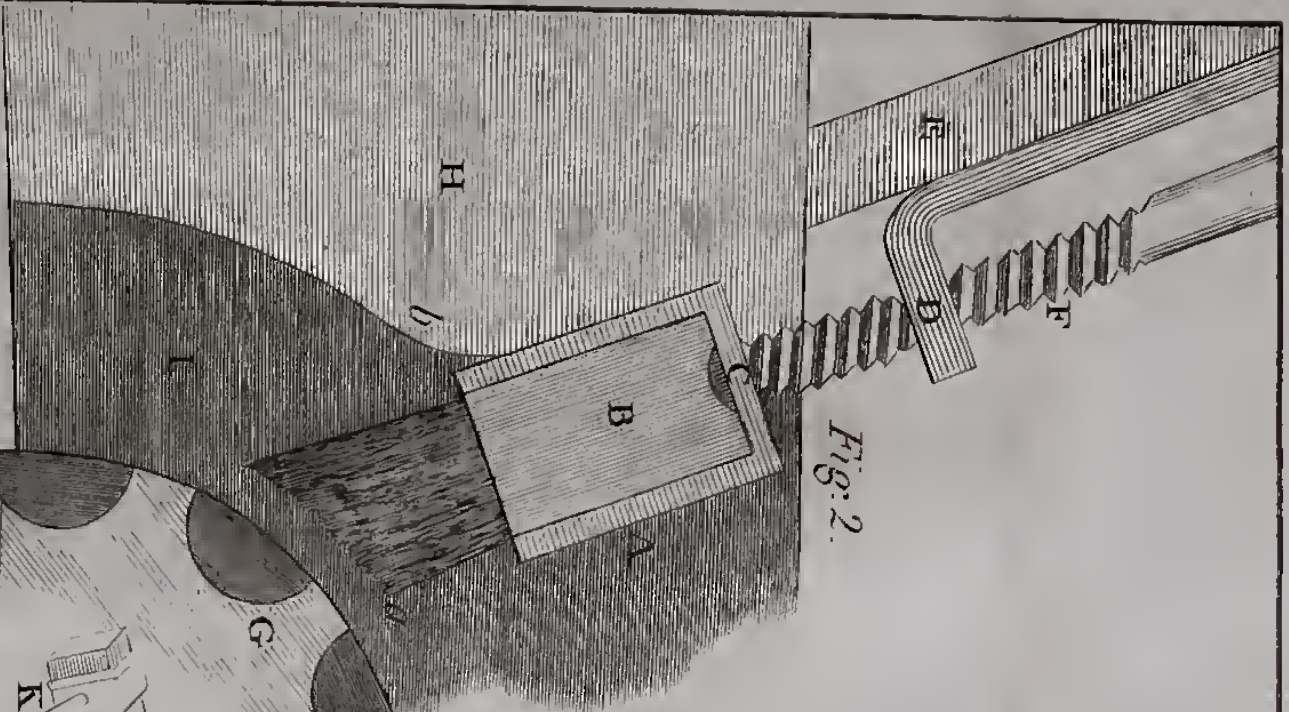
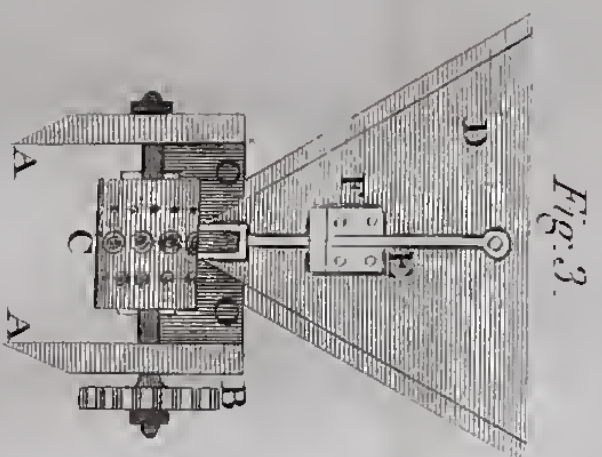
I. a continuation of the groove in which the socket moves, rounded off at *b* to prevent the feed from being bruised after it has passed the brush.

FIG. 3. FIG. 3. is a section of the feed wheel, frame, and hopper.

A A. the two side boards, seven by one inch square.

B. the movement wheel, on the axle of which the feed wheel is fixed by two pins.

C. a



C. a profile of the feed wheel, four inches long, and three inches diameter, of which ^{PLATE VII.} FIG. 3.
FIG. 1. PLATE 5. is a geometrical construction.

D. the end of the hopper next the handles of the plough. The bottom is three inches wide, the top twelve, and the depth eight.

E. the handle of the regulator, of which FIG. 2. is a geometrical construction.

F. is an iron plate nailed to the end of the feed hopper, in which the screw of the handle works, and thereby raises or lowers the socket and brush, by which the quantity of seed is either increased or diminished; which any person may easily discover, and by the least attention soon learn how to set the regulator, so as to sow any definite quantity of seed upon an acre. All of which is so clear, that any farther description seems quite unnecessary.

C H A P. V.

General Directions for preparing the Land, and using the foregoing Machines:

BEFORE the drill husbandry can be attempted, the land should be brought into tolerable fine tilth.

For all land is not equally suitable for the drill and horse hoeing culture; and some, though comparatively little, not at all so: yet most land, except that which is rocky or abounding with stones, may be brought into proper order, by frequently ploughing, harrowing, and rolling.

If the soil is light and dry, one ploughing will be a sufficient preparation. But if the soil is wet, a stiff loam, or a strong clay, the ridges should be ploughed up as early in November as possible.

In

In about three or four weeks after, if the weather permits, the field should be ploughed across with a double mould board plough into one bout ridges, and afterwards well water furrowed by the same plough. The field will then lie in deep open furrows, and high narrow ridges, and consequently exposed to the largest extent of superficies that is possible, which is the *sine qua non* of ploughing.

As the Spring advances, the ridges must be drawn down by the break or drag harrow, previous to the seed furrow for early crops. About the latter end of February, or beginning of March, the ridges should be split down the middle, and afterwards drawn down by the break or drag harrow, previous to the seed furrow for the late spring crops.

The land intended for fallow crops should be treated in the same manner, and afterwards ploughed and properly prepared for the reception of the seed or plants.

Where unequal and very high ridges are already
formed,

formed, they should be drilled across, until there is time to level them ; which may be done with safety in the course of two fallowings, by ploughing the ridges twice down for once up.

In moist soils, the field should be formed into straight ridges of five feet and a half wide for one breadth, and into eleven feet ridges for two breadths of the machine; and in dry soils, into ridges of sixteen feet and a half wide for three breadths of the machine, which are the best on dry soils, as there is just a breadth and a half on each side of the middle.

In every instance the land should be well harrowed, and once or twice rolled before it is drilled, and afterwards harrowed once in a place with a pair of light harrows, and then well water furrowed and gripped if necessary.

In drilling grain, pulse, seeds, &c. the land should neither be too dry nor too moist, but in a due medium with respect to both, and rather inclining to be mellow and crumbly.

*On using the Drill Machine with Spherical
Cups.*

FOR drilling at eight inches apart, all the coulters must be employed; and all the conductors, which are numbered 1, 2, 3, 4, 5, 6, 7, 8, must be applied to their respective places, as represented in the perspective view of the machine.

For drilling at nine inches apart, seven coulters are only employed, when the order of the conductors will stand 2, 4, 6, 8—3, 5, 7, and no feed put into the feed trough opposite No. 1.

For drilling at ten inches apart, six coulters are only employed, when the order of the conductors will stand 4, 7, 8, 3, 6, 1, 2, 5, and no feed put into the feed troughs opposite Nos. 8, 1.

For drilling at twelve inches apart, only five coulters are used, when the order of the con-
B b
ductors

ductors will stand 5, 2, 3, 8, 7, 6, 1, 4, and no seed put into the seed troughs opposite Nos. 2, 7, 1.

FIG. 4. PLATE II. clearly shows the manner of fixing the coulter at any required distance, to which I beg leave to refer the reader.

When the machine is travelling from the farmyard, or from one field to another, it must be unlocked, which takes the coulters out of the ground; the stop must be also drawn back, to take the movement wheels out of gear.

Having fixed the coulters at the depth and distance at which the seed is required to be planted, the conductors in their respective places, filled the seed hoppers with an equal quantity of seed, and set the regulator according to the quantity of seed to be sown; the machine must then be placed about three feet from the end of the ridge, where it is to begin to sow.

Every thing being properly prepared and regulated,

lated, the driver must walk along the edge of the ridge or field, keeping the horse at such a uniform distance, so as the outside coulter of the machine may come within six inches of the edge of the ridge or field. When at the end of the ridge or field, the person that manages the machine must unlock it, and also take the movement wheels out of gear, to take the coulters out of the ground, and to stop the sowing while the machine is turning. When the machine is fairly turned round, it must be locked and geared again about three feet from the end of the ridge, that the cups may have time to fill with seed.

Fill the hoppers again if necessary, and in returning let the right hand land wheel tread upon the track of the right hand coulter; and so proceed until the field or ridge is finished, taking care to guide the machine as straight as possible.

If the field is formed into ridges of twelve feet wide, two breadths of the machine will cover them; in which case the horse must go in the middle of the fide, keeping the movement wheels

B b 2

always

always in the middle of the ridge, and the right hand outside coulter within four inches of its edge..

If the field is formed into ridges of one breadth of the machine, and the distance between the rows is eight inches, the horse will then go in the furrows, in which case no seed should be put into the seed troughs Nos. 4 and 5; and when the distance between the rows is nine inches, only one of them is empty.

If the field is formed into ridges of two or three breadths of the machine, the best way is to drill the edges of all the ridges first, by making the horse walk up one furrow and down another, and then to drill the middle of the ridges last.

But in whatever form the ridges are, the coulters should be fixed so as to form the same line, whether it be concave, convex, or level.

If the machine should happen to be too wide for any of the ridges, one or more of the conductors

ductors may be stopped up, and that feed returned into the feed hopper again.

In drilling unlevel land, the front edge of the feed hopper should be kept in a horizontal position; which is done at pleasure by the radius F, and the thumb screw G, in FIG. 3. PLATE I.

If the coulters should not deposit the feed deep enough, the back band may be shortened a little; if the feed is laid too deep in the ground, it may be lengthened; which will alter the depth at which the feed is deposited, without altering the coulters.

The person who manages the machine must take particular care that all its parts do perform their respective offices, that the hoppers are duly supplied with feed, that the conductors are not choked, nor the coulters clayed up; all of which being seen at one view, no errors can be committed, except such as are wilful, or through neglect.

On drilling Wheat:

THE first thing to be considered is the quality of the soil, in order to ascertain the quantity of seed to be sown upon an acre. If the soil is poor, the distance between the rows should not exceed eight inches, and the quantity of seed sown upon an acre should be about nine pecks, at two inches and a half deep. If the soil is of a middling quality, the distance between the rows should not exceed nine inches, and the quantity of seed eight pecks. If the soil is rich, the distance between the rows should not exceed ten inches, and the quantity of seed seven pecks, which should be pickled, limed, and dried completely.

On

On drilling Barley.

FROM what has been said on drilling wheat, little more need be said on drilling barley, as the quantity of seed and distance between the rows are nearly equal, on soils of equal quality.

But as barley has not to withstand the severities of winter, the depth at which the seed should be deposited may be rather less.

And as the roots of barley are more tender and fibrous than those of wheat, they therefore require a finer tilth. But the depth and distance, at which grain should be planted, depend so much on the season, and on the condition and culture of the soil, that every occupier of land must therefore experiment for himself.

On drilling Oats.

THE roots of oats being strong and piercing, they are therefore generally sown upon land unfit for either wheat or barley; and as they do not *tillure* so much, a greater quantity of seed is therefore necessary to be sown upon an acre.

In drilling oats, the right hand land wheel D, and the movement wheels E and F, must be exchanged for the left hand land and movement wheels, which increases the quantity of seed sown upon an acre in the following proportion:

When the distance between the rows is eight inches, the machine will sow 14 pecks; at nine inches, 12 pecks; and at ten inches, 10 pecks.

On drilling Beans and Pease.

BEANS and PEASE being very succulent plants, they therefore require a greater distance between the rows, especially as they are peculiarly adapted to the horse hoeing culture. And the best distance I have always found to be about twenty-four inches. At this distance the machine can drill three rows at once; and with two feed wheels in every one of the feed troughs that is employed, eight pecks of seed will be sown: Beans having a very strong tap root, the seed therefore requires to be deposited at a pretty good depth; and my experiments show that about three inches is the best depth.

On drilling Turnips and Rape.

HAVING prepared the seed as directed before, nothing more is necessary to be done, but to reverse the seed wheels, and fix the coulters at the distance at which you intend the rows to be asunder.

On poor soils I have always found that ten inches is the best distance, and on rich ones twelve, and about one inch the best depth. When turnips are sown at a greater distance, they grow too large for keeping long. On very rich soils, a greater distance may be adviseable, but then they should be eaten off before Christmas. It is an experimented fact, that the smaller the turnip, the longer it will resist the winter's frost.

On drilling Carrots.

FOR every acre to be drilled, take two pounds of carrot seed (which has been steeped in rain water for 24 hours, and which has lain upon a floor until it has speared), three pecks of dry saw-duft, and three pecks of fine dry mould, all thoroughly mixed together; and drill it about one inch deep, and fourteen inches between the rows, with the same cups which are used for wheat or barley. In about eight or ten days the plants will begin to appear; and the sooner they come up, the sooner they will get above the weeds. After drilling, the land should be harrowed once in a place.

A T A B L E

Shewing the Quantity of Seed sown per Acre,

At Inches between the rows.	Wheat sown by the wheels.		Barley sown by the wheels.		Oats sown by the wheels.		Beans sown by the wheels.	
	B & C	E & F	B & C	E & F	B & C	E & F	B & C	E & F
	Pecks.	Pecks.	Pecks.	Pecks.	Pecks.	Pecks.	Pecks.	Pecks.
8	9	14	9	14	9	14	—	—
9	8	12	8	12	8	12	—	—
10	7	10	7	10	7	10	—	—
12	6	8	6	8	6	8	—	—
18	—	—	—	—	—	—	12	14
20	—	—	—	—	—	—	10	12
24	—	—	—	—	—	—	8	10
32	—	—	—	—	—	—	7	8

On

*On using the Drill Machine with Indented
Cylinders.*

THE manner of using this drill-machine being exactly similar to the preceding one, little more therefore need be said on that head. But as they differ materially in their feed wheels, and manner of delivering the feed, it will therefore be necessary to point out how this machine may be regulated so as to drill all kinds of grain, pulse, feeds, &c.

Having given exact drawings of all the respective parts of this machine, the mode of delivering the feed, and regulating its quantity, will be easily understood from a bare inspection of those drawings.

When the brushes of the regulators touch the feed wheels, or cylinders, a very small quantity of feed is delivered; but the quantity may be greatly increased by raising the regulators as represented in FIG. 2. PLATE VII. All of which
are

are so plain, that the least attention will soon teach any person to know how to set the brushes of the regulators so as to sow any quantity of seed required upon an acre, as the cavities of the seed wheels, or cylinders, are proportioned to the size of the seed to be sown, and the distance required between each dropping; by which means the same frugality is preserved, whether the seed be large or small, as the different sized cavities are easily brought under the brushes by shifting the seed wheels one inch either to the right or left hand, and then pinning them fast.

This drill machine can sow any quantity of seed upon an acre from six to sixteen pecks. And as the seed is close covered up, no kind of weather obstructs its performance when the land is in proper order for sowing; nor can the start of a horse, or any inequalities of the ground, have any effect on the delivery of the seed.

It makes no material difference which of the two machines is employed, as the preparation of the land, and mode of managing them, are equally the

the same. And the directions for drilling any particular kind of grain, &c. with the former machine, are equally applicable to the drilling any particular kind of grain, &c. with this. The only thing in this machine that requires particular attention, is to fill the feed hoppers with an equal quantity of feed, and to see that all the feed wheels deliver it equally ; and if any of the feed hoppers are sooner or later in being emptied than the others, the brushes must be set a little nearer, or farther from the feed wheels. All of which the man who manages the machine may easily see, and soon learn to regulate the brushes, so as to sow any required quantity of feed upon an acre.

The following Table shows, at one view, how to regulate the machine so as to sow any proper quantity of feed per acre.

A TABLE

A TABLE

Showing how to regulate the Machine with Indented Cylinders.

FOR WHEAT AND BARLEY.

When the quantity of feed per acre is	Pecks.	And the distance between the rows is	Inches	Set the brushes so that	Revolutions of the land wheel may sow one pint for every coulter used.
	10		8		
	9		8		
	8		8		
	8		9		
	7		10		
	6		12		
					54
					56
					64
					56
					58
					56

FOR OATS.

When the quantity of feed per acre is	Pecks.	And the distance between the rows is	Inches	Set the brushes so that	Revolutions of the land wheel may sow one pint for every coulter used.
	16		8		
	14		8		
	12		8		
	12		9		
	10		10		
					34
					36
					42
					37
					40

FOR BEANS AND PEASE.

When the quantity of feed p. ac. is	Pecks.	And the distance between the rows is	Inch.	Set the brushes so that	Revolutions of the land wheel may sow one pint for every coulter used.
	12		20		
	10		24		
	9		27		
	8		28		
					18
					17
					16
					18

On

On drilling Turnips and Cole.

IN drilling turnips and cole the cylinders must be shifted one inch towards the right hand, which brings the smallest cavities under the brush, for sowing all kinds of small feeds as well as turnips and cole.

If the land is properly prepared, and the feed, as above directed, nothing more is to be done but to set the brushes to strickle the feed wheels easily, the coulters at their proper distances and to fill the feed hoppers opposite the tin conductors, and then proceed as already directed.

On drilling Carrots.

HAVING prepared the land, and the feed as before directed, nothing more is necessary to be done but to set the coulters at the distance at which the rows are intended to be asunder, and the brushes so as to sow the quantity of seed (by the large cavities) intended to be sown, and then the machine is equipped. Proceed in the same manner as already directed; and when the drilling is finished, the field or plot must be harrowed with a pair of light harrows, and then rolled.

On

*On using the Drill Plough with Indented
Cylinders.*

EQUIP the plough with the drill apparatus as represented in PLATE 7. FIG. 1. Place the proper cavities under the brush, for the seed intended to be sown; set the coulter to deposit the seed at a proper depth; regulate the brush as directed for sowing with the drill machine with indented cylinders; fill the hopper with seed; place the plough straight to the end of the furrow, where you intend it shall begin to sow, and then drive forward.

When you are at the end of the ridge or field, the ploughman must take hold of the handle C, and bring it down to the handle of the plough so as he may grasp both, by which the land wheel is lifted off the ground, and instantly stops the sowing while the plough is turning round at the end of the ridge or land.

When the plough is fairly turned round and placed straight to the furrow, fill the hopper with feed if necessary, let down the land wheel, and then drive forward, proceeding in the same manner until the ridge or field is finished; always taking care to keep the plough upright.

In beginning a ridge it is sometimes necessary to miss sowing the first furrow, which is generally thrown back by the second, that all the land may be ploughed clear in the middle of the ridge, &c. And in finishing a ridge the last furrow should be ploughed very thin, and without feed, that it may serve as a covering to the preceding row of grain, &c.

The distance between the rows is regulated by the breadth of the plough furrow, which may be made narrower or broader at the option of the ploughman, and that distance and the adjusting of the regulator governs the quantity of seed to be sown upon an acre.

When the distance between the rows exceeds 8 the

the breadth of one furrow, every second, third, fourth, or fifth furrow may be drilled, and the breadth of each furrow should be proportioned to the distance required between every row.

If the land is rough and cloddy, it should be rolled and harrowed once in a place; but if the land is in fine tilth, it had better lie as the plough left it.

The table showing how to regulate the drill machine with indented cylinders, will likewise show how to regulate this drill plough.

C. FIG. 3. PLATE VII. is a profile of the feed wheel set for sowing all kinds of large grain. Shift it one inch to the left hand, and the middle sized cavities are brought under the brush, for sowing middling sized grain. Shift it one inch to the right hand, and then the smallest cavities are brought under the brush, for sowing all kinds of small seeds. In these shiftings the feed wheel must be made fast by a pin fixed in the axle at the right or left ends. In sowing large grain two pins are
necessary,

necessary, one at each end of the feed wheel, to keep it in the middle, as is here represented.

When this plough is wanted for common purposes, the drill apparatus may be taken off in a few minutes. From a variety of experiments in the drill husbandry, made upon land of various qualities, and conducted in the same manner as those already inserted in this work, the following table was formed.

A TABLE

A T A B L E,

Showing the quantity of seed most proper to be drilled upon an acre of land of various qualities, and the best distance between the rows so as to produce the largest crops possible.

Kind of soil.	Wheat.		Barley.		Oats.		Beans.	
	Quantity of seed.	Distance between the rows.	Quantity of seed.	Distance between the rows.	Quantity of seed.	Distance between the rows.	Quantity of seed.	Distance between the rows.
	Pecks	Inches	Pecks	Inches	Pecks	Inches	Pecks	Inches
Poorest	10	8	12	8	16	8	12	18
Poor.	9	8	10	8	14	8	10	20
Rich.	8	9	8	9	12	9	9	24
Richest	7	10	7	10	10	10	8	28

I am truly sensible that no certain standard can be fixed for the quantity of grain which ought to be sown upon an acre of land: this must differ as the circumstances differ that attend it. The soil, season, climate, state of the land, and the size of the grain, require more or less, as these are different.

According

According as these circumstances obtain, intermediate quantities of seed may be sown per acre, on land of intermediate qualities.

The reputation of the drill system has suffered materially from its own advocates, recommending too small a quantity of seed to be sown upon an acre.

When too small a quantity of seed is sown, upon the richest soils, the crop keeps *tilluring* till it is time to cut it down. In which case there is always a great number of small ears and light grain, which greatly reduces the value of the crop.

C H A P. VI.

On hoeing.

HOEING is the breaking, dividing, or pulverizing the soil between the rows of corn that have been drilled, or between plants that have been set in rows with intervals between them; and is one of the most important operations in the drill-husbandry.

The advantages arising from hoeing are great and numerous. By it weeds are destroyed; the pasture of plants increased; the fertility of the soil greatly restored; vegetation promoted; and the land half prepared for a succeeding crop.

Rain, snow, hail, dew, &c. are easily absorbed by the earth, when it is kept in a loose, light, pulverized state; whereas the same principles on a compact hard soil reach no farther than the

E e

surface,

surface, and are again exhaled by the sun and wind, with little or no benefit to the soil they fall on.

Pulverizing the land is wonderfully efficacious on stiff or loamy soils; but on light, sandy, and thin ones, too much ploughing and hoeing will prove hurtful.

In all operations of hoeing, the land should neither be too dry nor too moist, but in a due medium with respect to both.

Light dry soils may be hoed almost any time, but stiff moist soils cannot be hoed but at particular seasons; and that is, when the soil is in a crumbly mellow state.

Grain or small seeds, when drilled with narrow intervals, must be hoed with small shares proportioned to the distance between the rows. But pulse and other plants that are drilled, or set at a greater distance, require larger and stronger instruments; the construction and use of which shall be the subject of this chapter.

On

On the Construction of Hoe Machines.

THE first machine that I would recommend, is a small *Rotherham* or *patent plough*, or the common plough of any country made upon a smaller scale, and that has a broad sharp share.

On stiff soils, and wide intervals, these ploughs are preferable to any other hoe machine ; as they can go as deep as you please, may be worked very near the rows, and, if the land is in tolerable tilth, one horse will be able to manage them.

The second is a *plough with two expanding mould boards*, for earthing up the rows of plants on each side at once going. It will also serve the purpose of clearing the cross drains, or water furrows of the field, at a small expence.

These instruments are so simple in their construction, and so well known, that a minute detail of their parts would be superfluous.

For narrow intervals and mellow soils, my new invented *expanding horse hoe*, the *six shared horse hoe*, and the *breast hoe* must be used.

On the Construction of the expanding Horse Hoe.

THE superiority of this hoe in preference to any other, consists in its expanding shares, which are capable of being extended or contracted at pleasure, from 12 to 30 inches, consequently can hoe intervals at any width between those extremes.

P L A T E VIII.

FIG. 1. Is a profile of the expanding *horse* ^{PLATE}
hoe, and harrow. ^{VIII.}
 ^{FIG. 1.}

A. is the regulating wheel, ten inches diameter, and which can be so adjusted that the shares may cut at various depths.

B. the beam, six feet six inches long and three inches and a half square.

C. the leading share, riveted on the shank D, and is an equilateral triangle of twelve inches.

D. the shank of the leading share, which is fixed in the beam, as per figure, and is two by half an inch square.

E. represents the edge of the expanding shares, which are two feet long and five inches broad, shaped as per figure.

F. repre-

PLATE F. represents the left hand mould board,
VIII.
FIG. 1. which is made of a piece of light wood two
feet long, and ten by six inches square.
These mould boards are hooked on the iron
rod G, and fixed to the shank H by a screw
bolt.

G. is an iron rod which passes through the hind part of the leading share, the fore part of the expanding shares, the mould board hooks, and the beam, in which it is fixed by a nut and screw on the upper side.

H. is an iron shank fixed to the expanding shares, kneed at the top, where a circular part passes through the beam, and regulates the width of the expanding shares.

I. the handle, which is three feet from the ground line, and that part which the man grasps is three feet behind the end of the beam.

K. is a profile of a small triangular harrow
with

with expanding fides, fixed to the end of the beam, as per figure. This harrow is of great use in tearing up the weeds that have been cut by the hoe; and by shaking the earth from their roots, and leaving them on the surface of the land, by which they are exposed to the sun, which soon kills them.

PLATE
VIII.
FIG. I.

This hoe may be made complete for two guineas; and the harrow which follows for one.

FIG. 2. is a horizontal view of the *expanding hoe*, and harrow.

FIG. 2.

B. the beam, in which are mortices for the reception of the shanks of the regulating wheel, and the leading share.

C. the leading share, to which the expanding ones are fixed by the bolt G, as represented in FIG. 1.

D D. the expanding shares fixed to the leading one C.

2

E E. the

PLATE
VIII.

FIG. 2.

E E. the circular radiuses of the shanks that are fixed to the inside of the expanding shares; these go through the beam, and regulate the width of the hoe, and are fixed to any width by two bolts passing through them and the beam.

The dotted lines F represent the upper part of the mould boards; and show how they incline outwards behind, how they are fixed to the shanks of the expanding shares, and how they are hooked on the iron rod, which passes through them, the leading share, and the beam.

G. the middle bun of the *expanding harrow*, three inches square, and two feet nine inches long.

H H. the expanding buns, three inches square, and two feet six inches long. These buns are fixed to the middle one by strong hinges, as per figure.

I I. two circular radiuses, made of iron and fixed in the expanding buns. These radiuses

pass through the middle bun, in which there are two holes corresponding to those in the radiuses for setting the harrow to any width. PLATE
VIII.
FIG. 2.

All of which are so plain, that any farther description would be unnecessary.

The utility and simplicity of this hoe have induced many farmers to adopt it for hoeing their beans ; which are sometimes drilled and sometimes sown by hand in equidistant rows. It is also equally applicable to the hoeing of potatoes or cabbages with expedition.

FIG. 3. is a profile of the *fix shared horse* hoe made on the principle of the pentagraph, and to move with great ease to the right or left ; by which means the person who manages the hoes will be able to keep them in the middle of the space between the rows of corn. FIG. 3.

This hoe is not of my invention. I have only improved it, by adding the two castor wheels which regulate the depth.

F f

A. is

PLATE A. is a section of the coulter bar of the
VILL.
FIG. 3. drill machine, to which this horse hoe is
fixed by an eye bolt, as per figure.

B. is a piece of ash wood three inches square, sixteen inches long, and made narrow before towards the eye, which hooks on the bolt that goes through the coulter bar.

C. is another piece of ash wood three inches square, and thirteen inches long. These pieces of wood are fixed between iron bars at the distance of twelve inches from one another, by four screw bolts, as per figure.

The iron bars are about two inches broad, half an inch thick, and forty-one inches long.

D. is a section of the coulter bar, four by three inches square, and moves in the oblong space between the two pieces of wood and the iron bars.

G. the

G. the share with its shank fixed in the coultter bar ; the shank is sixteen inches long, one inch and a half by half an inch square, and is riveted in the hind part of the share.

PLATE
VIII.
FIG. 3.

E. the castor wheel eight inches diameter, and about two inches thick at the centre. This wheel not only regulates the depth of the hoes, but also makes the whole machine move easier either to the right hand or left.

F. the handle fixed to the piece of wood C by two bolts and screws, as per figure : this handle projects about twenty-five inches behind the side frame to which it is fixed, and is about thirty-four inches from the surface of the ground.

FIG. 4. is a horizontal view of the *six shared horse hoe*.

FIG. 4.

A. represents the coultter bar of the drill machine, to which the hoe is fixed by two eye bolts,

F f 2

B. the

PLATE
VIII.

FIG. 4.

B. the iron bars, between which the coulter bar moves upon a bolt which passes through the whole. In these bars are five bolt holes for shifting the bar with the hoes forward, backward, or diagonally.

D. the coulter bar, or the bar in which the hoes are fixed. The figures 8 and 9 show how to fix the hoes, when the rows of corn are eight or nine inches asunder.

G G G. are three shares in the form of an isosceles triangle; the two fore sides of which are seven inches long, and the hind side six.

As eight or nine inches is the best distance between the rows of grain; so hoes of six inches wide are the best adapted to those distances, and will answer very well for both.

F. the handle of the left side, fixed to the end of the side frame by two bolts, as per figure.

The numerical figures 1, 2, 3 and 4, re-
 present four rows of corn at nine inches
 afunder.

PLATE
 VIII.
 FIG. 4.

FIG. 5. is a horizontal view of a *coulter*, of
 which there are seven ; which are used instead
 of the triangular hoes, on stiff, gravelly,
 stony, or on soil infested with couchgras.
 These coulters are thirteen inches long below
 the coulter bar.

FIG. 5.

FIG. 6. is a profile of one of the said *coul-*
ters, made sharp on the fore edge for cutting
 the ground with more ease, while the broad
 part flirs the earth below : the whole has been
 laid down from the annexed scale.

FIG. 6.

FIG. 7. is a horizontal view of a *hand or*
breast hoe for hoeing narrow intervals, the
 fore edge of which is six inches broad, the
 long handle six feet long, and the cross one
 two : this hoe will hoe intervals of eight
 or nine inches wide very well.

FIG. 7.

If

PLATE - If the intervals are ten or twelve inches
VIII.
FIG. 7. wide, the hoes must be eight or ten inches
broad.

FIG. 8. FIG. 8. is a profile of the same hoe, in order to show its form when at work. But since the invention of the *six-shared horse hoe*, this hoe has not been much used.

Fig. 7.



Fig. 1.

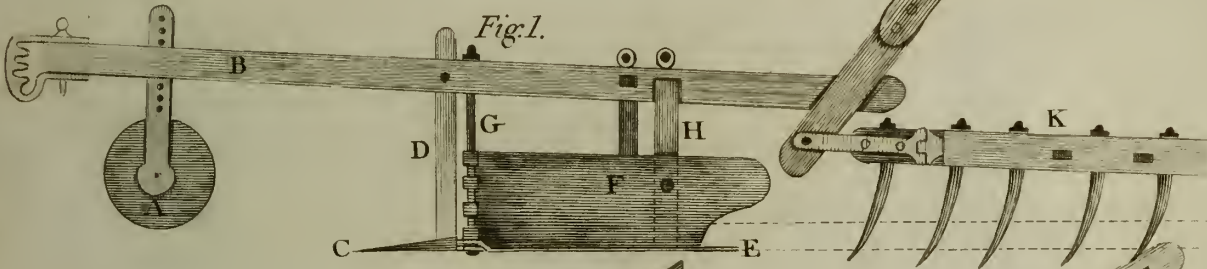


Fig. 2.

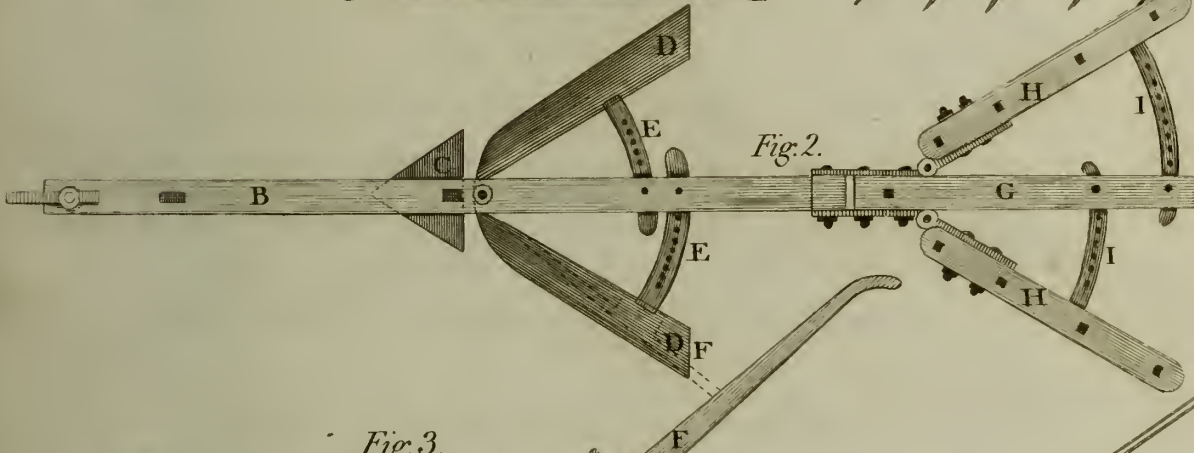


Fig. 3.

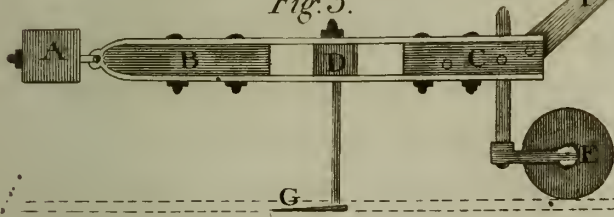


Fig. 8.

Fig. 6.



Fig. 5.

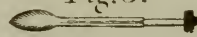
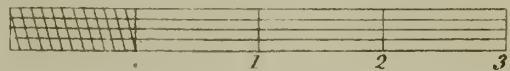
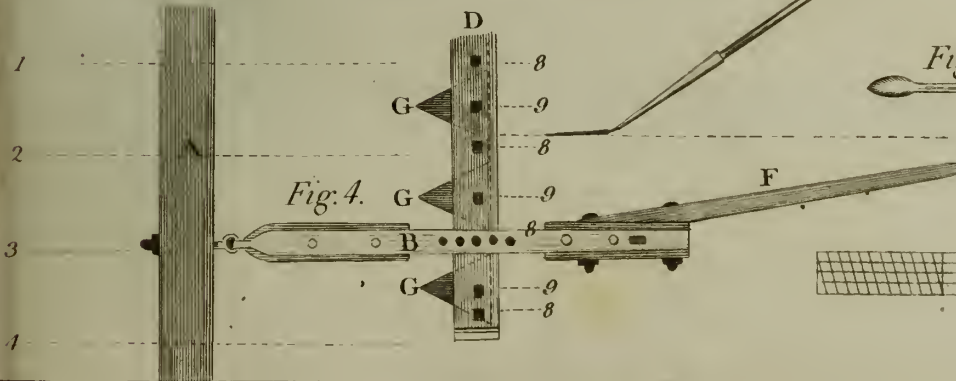


Fig. 4.





On hoeing Wheat.

WHEAT has two kinds of roots; the one is called the *feminal*, the other the *coronal* root. The *coronal* root seldom appears till the latter end of March, or beginning of April. This is therefore the season for seconding the efforts of nature, by going over the field with a pair of light harrows; which not only destroy the weeds, but also give the *coronal* roots an earthing up. After the harrowing is finished, the field should be immediately rolled to press the soil about the roots of the plants, and to prepare it for a second hoeing.

About the beginning of May, or sooner, the second hoeing should be given either with the *fix-shared horse hoe*, or the *breast hoe*. With the latter only one row can be hoed at a time; with the former six or seven rows can be hoed according to the distance between them.

When this hoe is used, the feed hoppers, &c. should

should be all taken away, and nothing left but the frame of the drill machine; to the coulter bar of which the hoe is fixed.

In hoeing with this hoe the horse must go exactly in the same place where the horse went when drilling, using one hoe less than the number of rows drilled; and that interval between the breadths of the drill machine should be hoed with the *hand hoe*, on account of the interval being unequal from the unsteadiness of the horse; and if the person who attends the machine will keep his eye continually on one of the hoes, so as to keep it in the middle of the interval, all the rest will be sure to be right.

When the person who guides the hoes wants to move them to the right or left, so as to keep them in the middle of the intervals, he should lift up the handles a little when he moves them.

It makes no material difference whether the hoes or coulters are used, as the mode of managing

naging them are equally the same; and the directions given for using the hoes are equally applicable for using the coulter.

The third hoeing should be given the latter end of May or beginning of June, which greatly invigorates the coronal roots, and promotes the growth of the stems.

The fourth hoeing, if necessary, should be given the latter end of June, or beginning of July, as circumstances require.

But as soils and seasons vary exceedingly, it is impossible to ascertain the precise time when those hoeings should be given. Much therefore depends upon the discretion and judgment of the husbandman; but in no case should the weeds be permitted to gain the ascendancy.

On hoeing Barley.

BARLEY has likewise two sets of roots, the seminal, and the coronal, which forms itself in about three weeks after the grain has been sown. Upon the appearance of this root the field should be harrowed, and then rolled for the first hoeing.

The second and third hoeings should be given at proper intervals of time, and should be performed exactly in the same manner as directed for hoeing wheat.

On hoeing Oats.

As soon as the coronal roots begin to make their appearance, the field should be harrowed, and rolled for the first hoeing.

The second and third hoeings, if necessary, should be given in due time, and should be performed as directed for hoeing wheat.

On hoeing Beans and Pease.

As soon as the beans or pease can be properly distinguished in the rows, they should be rolled and harrowed, which completes the first hoeing.

If the soil is mellow, the *expanding hoe* should be used about the middle of May, when the beans will be sufficiently established in the ground, so as not to suffer from the free use of it; the shares should be kept very sharp, to cut the weeds with ease, so that the expanding harrow may bring them more completely to the surface, which finishes the second hoeing. In this situation they may remain for three or four weeks, or till more weeds appear, when they should be skim hoed a second time, which completes the third hoeing. In a few days after, the rows should be hand hoed well, and then earthed up, which finishes the fourth hoeing. In two or three weeks they should be hand weeded, and then earthed up a second time, which completes the number of hoeings.

If

If the soil is stiff, gravelly, or stony, the hoe plough recommended before should be used to give the second hoeing, by ploughing a furrow off from the beans on each side, making a ridge in the intervals between the rows; the beans will then stand upon a ridge of about six inches wide, which should be well hand hoed. In about a week after, the double mould board plough should be used to earth up the plants in the rows. In two or three weeks they should be hand weeded again, and, as soon as the weeds are dead, they should be earthed up by the double mould board plough a second time, which finishes the operation of hoeing.

On hoeing Turnips.

As soon as the turnips have got four vigorous rough leaves, they should be harrowed with a pair of light harrows.

In two or three weeks after, the second hoeing should be given either by the *breast* or *six-shared horse hoe*, to cut up the weeds in the intervals; and those weeds which are in or near the rows must be cut up by the hand hoe, and the turnips thinned at the same time.

In two or three weeks more, the third hoeing should be given by the same hoes; the rows should also be well hand hoed, and the turnips set out single to their proper distances.

What has been here said with respect to hoeing turnips, is equally applicable to the hoeing of cole, except the harrowing, which ought to be omitted.

On hoeing Carrots.

As soon as the carrots are about two or three inches above the ground, they should be harrowed; in which case as many harrows should be tied to a pole as will cover the ridges, and the horses made to walk in the furrows, to prevent treading the land, or injuring the plants.

In two or three weeks after harrowing, the second hoeing should be given to clear the intervals of weeds; and those that are in or near the plants in the rows, must be cut up with the hand hoe, and the carrots thinned at the same time.

In that situation the carrots may remain for two or three weeks, or till more weeds appear. The hoes must then be set to work again, the *breast* or *horse hoe* to clear the intervals, and the hand hoe the rows; and if any double carrots are left, they must be removed, and those that are to stand for the crop must be set out to their proper distances.

On

On hoeing Potatoes.

As potatoes in general are planted upon light mellow soils, the *expanding horse hoe* is therefore peculiarly adapted to their cultivation.

I have cultivated potatoes upon a very large scale, and I never found any instrument equal to it, for expedition, and complete execution of hoeing at the least expence.

As soon as the potatoes are fairly above ground, they should be harrowed once in a place for the first hoeing. In about two weeks after, they should be skim hoed, for the second hoeing.

In two or three weeks more they should be skim hoed again, observing always to use the expanding harrow to tear the weeds out of the ground after they have been cut with the hoe. Immediately after this second skim hoeing, the potatoes should be well hand hoed in the rows. As soon as the weeds are dead enough, the plants in the
rows

rows must be well earthed up, which is done by the same hoe equipped with the mould boards as already directed. As soon as more weeds appear, and before the potatoes spread too much, they should be hand weeded in the rows, and then earthed up well a second time.

If any more weeds appear, and are likely to run into seed before the potatoes are taken up, they must be pulled up by hand and carried off the field, or laid in heaps and burnt.

On hoeing Cabbages.

As the month of May is the prime season for planting cabbages to stand through the winter, the planting therefore should be finished in that time.

In about three or four weeks after they have been planted, the *hoe plough* should be introduced, to plough a furrow off from the cabbages on each side, making a ridge in the intervals; the cabbages will then stand upon a flat ridge of six or eight inches broad. These ridges must be well hand hoed, and the earth drawn up to the cabbages at the same time. After the hand hoeing is finished, the *expanding harrow* must be set to work to harrow the ridge in the intervals, which tears up the weeds, and leaves them on the surface of the land, where they soon die.

In about ten or twelve days after being harrowed, the *hoe plough* must be set to work again, to plough back the earth to the cabbages on each side of the rows.

In about two weeks after they have been earthed up, the bottom of the intervals must be scoured up, either with the *expanding horse hoe*, or the *double mould board plough*. This last operation has not only a beneficial, but a most delightful effect, and should be repeated a second time as soon as more weeds appear, and before the cabbages spread so much as to prevent the horse from walking in the intervals without injuring them. If any more weeds appear, they must be pulled up by hand, and the caterpillars (if any) killed at the same time.

F I N I S.

A P P E N D I X.

A P P E N D I X.

SINCE this work went to the press, I have reconsidered the directions given for preparing land for drilling.

I have already recommended winter ploughing all kinds of soils (except light ones), which not only fertilizes the upper surface of the soil, but also lessens its tenacity, and reduces it to a fine mould.

As the surface soil is by this means finely ameliorated for the reception of the seed, it would be a pity to bury it by a second ploughing. I would therefore recommend the use of the following SCUFFLE ; which not only destroys seedling weeds, but also pulverizes the surface soil sufficiently without burying it. The construction and use of which is as follows.

P L A T E IX.

PLATE IX.
FIG. 1. is a profile of the *Scuffle*, with its appendages.

A A. represents the wheels on which it is carried from one field to another, and by which the depth of working is regulated. These wheels turn round upon their axles, and also upon the under end of the upright shank, in imitation of bed castors.

B. represents the middle beam, to which the horses are fixed.

C. the side beams.

DD D. the shank of the shares fixed in the beams by nuts and screws. They are fifteen inches long below the beams, made of iron, one inch and a half by half an inch square.

EEE.

E E E. the shares riveted on their flanks. PLATE
IX.
FIG. 1.

F. the handle for managing the machine,
a the surface, *b* the depth.

FIG. 2. is a horizontal view of the scuffle. FIG. 2.

A A A. represents the mortice holes that receive the flanks of the wheels.

B. the middle beam, about six feet nine inches long, and five by four inches square.

C C. the two side-beams, which are about five feet long and four inches square.

E E E E E. are five shares in the form of an isosceles triangle, the hind side of which is nine inches long, and the other two sides are each twelve inches; so disposed as to cut forty-five inches clear.

F F.

PLATE
IX.
FIG. 2. } F F. the handles which govern the ma-
chine.

G. a bar four inches square for bracing the machine together, and for receiving the shanks of the hind wheels.

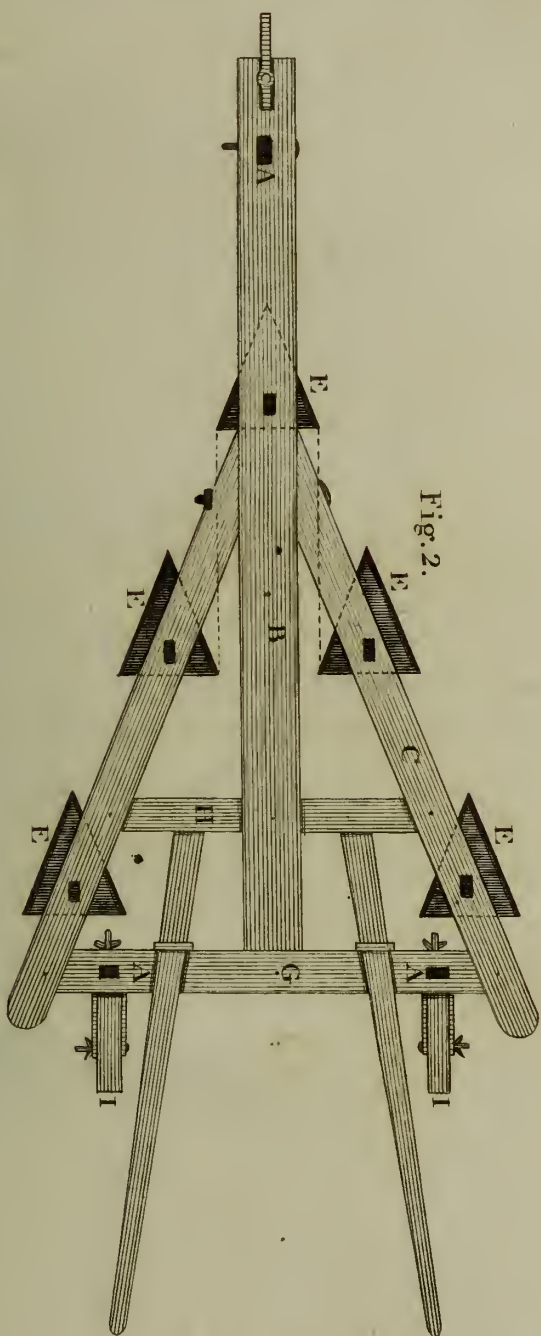
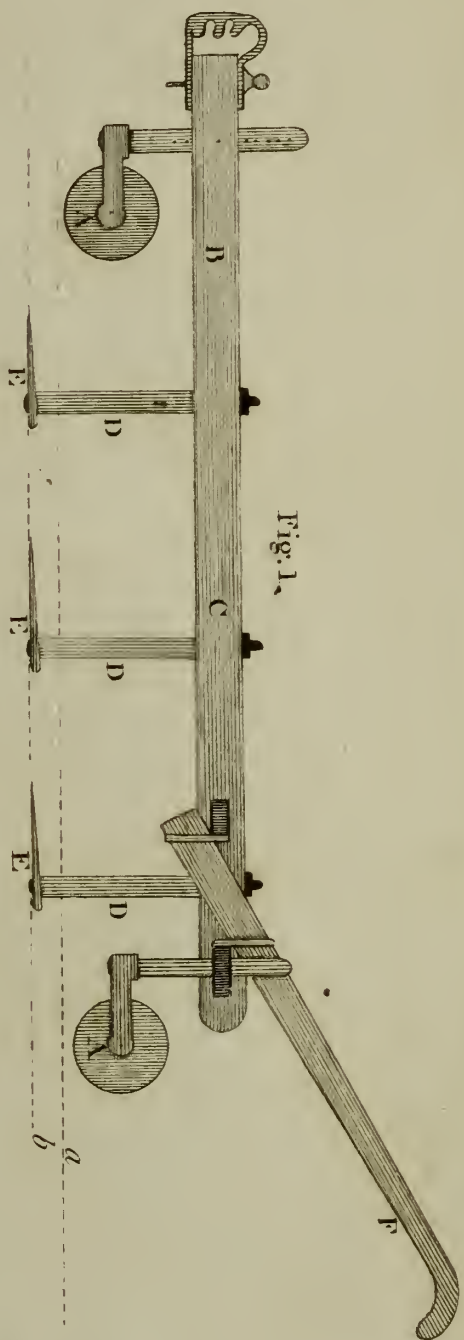
H. another bar three by one inch square.

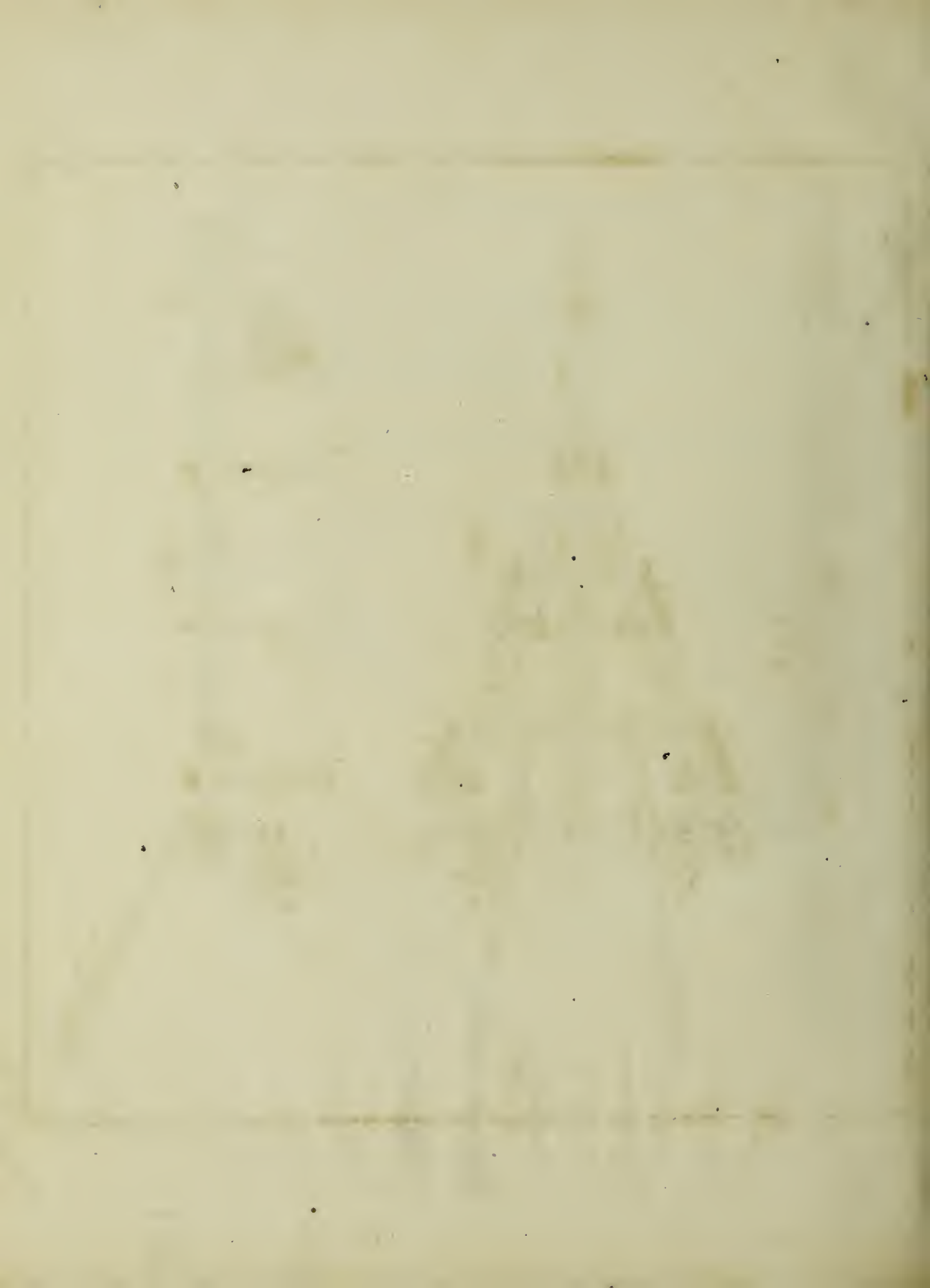
I I. the hind wheels.

FIG. 3. FIG. 3. is a scale of feet, inches, and quarters of an inch, from which the whole has been laid down.

THE use of this scuffle is of great importance in the drill culture, and a necessary appendage to the drill machines. For one man with four horses scuffles about five acres per day, which is a vast saving, when compared with the expence of ploughing, and much more expeditious.

After





After the land has been winter ploughed, laid up in proper ridges, and completely drained, nothing more is necessary to be done till the season for sowing.

As soon as the land is fit for receiving the seed, it must be scuffled to the depth of about three inches or more for barley and oats, harrowed twice in a place, then drilled, and afterwards rolled and harrowed again; which in general completes the work.

Mellow land, that has been cropped with beans, or beans and pease, requires no other preparation than scuffling, harrowing, &c. previous to its being drilled with wheat.

Land sown with garden pease, which are got off the latter end of July, may be scuffled, harrowed, and cleaned, and then drilled with turnip or rape seed.

Mellow soils, that have been cropped with turnips, carrots, cabbages, rape, &c. will require no other preparation than scuffling, harrowing, &c. previous to their being drilled, provided they have been properly ridged up before.

These are advantages too obvious to need any farther illustration.

When the drill plough is used, two ploughings are necessary ; one before Christmas, and the second when the seed is sown.

Some experimenters recommend the use of the scuffle in fallowing, where it saves two or three ploughings ; but of this mode of managing fallows I have not sufficient experience to give it my sanction. The judicious farmer must in this case experiment for himself, as circumstances and the nature of his soil direct.

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